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DESCRIPTIONS OF BOLCA FISHES.

BY C. R. EASTMAN.

WITH TWO PLATES.

CAMBRIDGE, MASS., U.S.A.:
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No. 1. *Descriptions of Bolca Fishes.* By C. R. EASTMAN.

THERE are two principal sources of information in regard to the marine fish fauna of the Eocene period, leaving out of account the minor evidence that is presented by detached hard parts, such as teeth and other fragmentary remains. The first of these, which is at the same time the most important and historically the most interesting, is that furnished by the tolerably abundant skeletons occurring in the fissile limestone of Monte Bolca and Monte Postale in northern Italy. The other is that association of ichthyic remains which is known from the nearly equivalent horizon of the London Clay.

These two faunas fortunately supplement each other to a considerable extent, one of them making us acquainted with the large variety of forms which flourished during the later Eocene, and the other supplying us with important anatomical details. For the conditions of preservation in clay beds are obviously very different from those which are peculiar to limestone. Calcareous sediments are more compact; and where pressure and subsequent hardening occur, bodies which are not absolutely rigid, like the skeletons of vertebrates, or even the outer covering of chelonians and crocodilians, are liable to become compressed and flattened out. Hence, as a general rule, the parts belonging to either side of the body in fishes become squeezed together and confused when preserved in limestone, and the pliant head-bones become more or less distorted and displaced. This is almost invariably the case with the fishes from Monte Bolca, and for a correct understanding of the cranial osteology we must turn to the uncrushed skulls from Sheppey and elsewhere.

The London Clay fauna,[1] however, is not nearly so rich as the Italian, either in point of numbers or variety; and it is accordingly the latter which provides us with the principal data for comparing the ichthyic representation of Eocene and modern times. Comparisons of this nature and of detailed structural modifications are of the very greatest importance, since by their means we are able to trace the direction and extent of variation and specialization that has been going on in certain groups during this interval. But the most striking fact which arrests our attention is not that variation should have advanced at such a slow rate since Eocene times as it apparently did, but that this process should have been quickened by such a sudden and enormous acceleration as took place at the dawn of the Tertiary system. Cretaceous forms pass away, leaving only here and there a few moribund survivors (*e. g. Pycnodus*, *Palaeobalistum*, etc.) in the Eocene, their place being taken by a host of modern types which appear for the most part absolutely unheralded. Not only does the Eocene fish fauna bear an overwhelmingly modern aspect, but many of its types are as highly specialized as they are to-day; and forms which at the present day are widely aberrant have representatives at least as far back as the Middle Eocene. It is evident that an "expression point" (to us Cope's apt term) was reached in the evolution of ichthyic life exactly corresponding to, and contemporaneous with that which is so well recognized in mammalian life, although the cause of the phenomena is in each case unknown.

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[1] Agassiz, L., Report on the Fossil Fishes of the London Clay (Rept. Brit. Assoc. Adv. Sci. pp. 279–310, 1845).

The literature of Bolca fishes is extensive, and material from the typical locality has become distributed throughout the principal museums of the world. Nevertheless, the authentic specimens which have served either for the establishment of species, or for extending our knowledge in regard to them, are preserved in comparatively few institutions. These are the only reliable standards we have to refer to in cases where the synonymy is confused; and as such cases are numerous, it is of importance to systematists to know where these standards are preserved and may be consulted for study. In the sequel, therefore, a list is given of all the type and figured specimens belonging to the largest single collection of Bolca fishes which at present exists. In the following brief historical summary it is hoped that some facts have been brought together relating to the study of this fauna which shall be of service to investigators.

1. Old Collections, and Early Studies of Bolca Fishes.

Although the priority of the Italian school of geology and palaeontology amongst those of other nations is clearly established, the share contributed by fossil vertebrates towards stimulating inquiry has been less generally appreciated. For this reason it may be profitable to cast a retrospective glance over the formative period of these branches of natural science, a period coëval with the literary reawakening in Italy. We need not, however, extend our survey so far back as to include the detached statements or speculations of classic authors, or even post-Augustan writers, such as Tertullian and Pomponius Mela, for, familiar as the ancients undoubtedly were with the occurrence of fossils, they do not appear to have been seriously concerned in attempts to account for their origin, nor did their views serve to enlighten subsequent progress. *Per contra*, the doctrines of Aristotle, followed blindly or enlarged upon by scholastic writers during the middle ages, acted as a positive hindrance. Minds which could accept without difficulty Aristotle's ideas of spontaneous generation were free to admit that mineral matter could take on of itself any conceivable shape, even mimicking animate forms. If living plants and animals could produce themselves, why not fossils, as readily? Avicenna,[1] for instance, most brilliant luminary of the Arabian circle of sciences in the tenth century, and whose *Canon Medicinae* remained the principal medical authority throughout the middle ages, proposed a *vis lapifidica*, and following him in the thirteenth century Albertus Magnus[2] affirmed his *virtus formativa*. At a still later period a "World-Spirit," or *Archaeus*, was predicated by Bauhin, and Libavius held that fossils sprang from germs or seeds, like living beings. Glimmerings of a spirit of experiment and observation are rarely in evidence before the fourteenth century. Until about this period nature-study in Europe continued at an extremely low ebb, Greek and Latin scientific works were unread in the original, and untranslated into the vulgar tongue, and popular concepts of natural history were perverted by the bestiaries.

FOURTEENTH CENTURY. In Cecco d'Ascoli (1257–1327),[3] the ill-fated author of *l'Acerba*, and sometime professor of philosophy in the University of Bologna, we discover a man of remarkable erudition and varied abilities, in many respects far ahead of his age. The work by which he is best known, an encyclopaedic poem of moderate literary merit, contains a vast number of observations on all manner of things natural and supernatural, in which the veritable and mythical are curiously blended. In Book I., Chapter viii. of *l'Acerba*, which is devoted to thunder, lightning, meteorites, earthquakes, and other physical phenomena, mention is made of the occurrence of fossils, although no definite explanation of their origin is undertaken, as has been claimed by Libri and others. Considering the period in which he wrote, we must admit Cecco to have been a first-rate observer, a good reasoner, and less credulous in his judgments than many of his predecessors and contemporaries. Caustic envy of Dante is conspicuous in various parts of his poem, especially in the concluding passage of Book IV., from which the following lines are taken: —

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[1] *Cf.* Wüstenfeld, F., Geschichte der arabischen Aerzte und Naturforscher, nach den Quellen bearbeitet. Göttingen, 1840.

[2] Sighart, J., Albertus Magnus, sein Leben und seine Wissenschaft, nach den Quellen dargestellt. Regensburg, 1857.

[3] Popular name for Francesco Stabili of Ascoli, whom Petrarch honored with a sonnet beginning, —

"Tu se 'l grande Ascolan che il monde allumi."

He has been made the subject within recent years of a thoughtful essay by Welbore St. C. Baddeley, and of a historical romance by Pietro Fanfani (*Cecco d'Ascoli, Racconto storico del secolo XIV.* Leipzic, 1871). *L'Acerba*, which was the immediate cause of the author's death, passed through a score of editions between 1473, the date of the earliest, and 1546. The latest bears date of 1820, at Venice.

"Quì non se canta al modo dele rane,
Quì non se canta al modo del poeta
Che finge imaginando cosse vane;
Ma quì respiende e luce onne natura,
Che a chi intende fa la mente lieta;
Quì non se regna per la selva oscura."

Less a stranger to fame than Cecco is Giovanni Boccaccio, "prince of story-tellers"(1313–1375), one of whose early amusements consisted in gathering fossil shells near his home in the Valdelsa, hard by Florence. Unusually intelligent and well educated himself, he deplored the prevailing ignorance of his age, and aided largely in reviving the study of classic literature in Italy. Amongst his more serious Latin works is a Geographical Dictionary,[1] a laborious but indiscriminating compilation, in which he refers to the occurrence of fossils, and agrees with Pomponius Mela (whose *Cosmography* he quotes) in considering them as having belonged to living bodies. A passage is also said to occur in Book VIII. of the *Filocopo*, by the same author, in which fossils are mentioned, and the inference is drawn from them that the land had been submerged beneath the sea; but Brocchi,[1] who is authority for this statement, appears to have been mistaken in his reference.

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[1] De Montibus, Silvis, Fontibus, etc., supposed to have been written about 1373. The passage on *Elsa fluvius* (q. v.) occurs on p. 456 of the Basle edition, 1589. *Cf.* also, by the same author, *Commento a Dante, Lezione LII*, in Vol. II., pp. 367–369, of the Milan edition, 1863.

On Boccaccio and the extent of his information, the following may be consulted: Hortis, A., Studj sulle opere latine del Boccaccio. Triest, 1879. — Koerting, G., Der Umfang des Wissens Boccaccios, in his Geschichte der Litteratur Italiens, Vol. II. Leipzic, 1880. — Landau, M., Giovanni Boccaccio, sein Leben und seine Werke. Stuttgart, 1877. — Libri, G., Histoire des sciences mathématiques en Italie, Vol. III. Paris, 1840. — A list of the older writers consulted by Boccaccio in the compilation of his *De Montibus*, etc., is published in Boll. Soc. Adriat. Sci. Nat., Ann. III. pp. 62–114.

On Dante as a naturalist, see Holbrook, R. T., Dante and the Animal Kingdom, New York, 1902.

SIXTEENTH CENTURY. Very few Cinquecentisti appear to have inquired into the significance of fossils. The first to claim our attention is Alexander ab Alexandro (1461–1523), a learned Neapolitan jurisconsult, concerning whom little is known save for personal statements interjected amongst a mass of miscellaneous information in his *Dies Geniales*.[2] In Book V., chapter ix., of this peculiar work, which first appeared at Rome in 1522, the author recalls having seen in the mountains of Calabria, at a considerable distance from the sea, divers sorts of marine shells heaped together and embedded in a variegated hard marble, so that they formed one mass: "*quas quidem ossea et non lapideas esse, et quales in litoralibus vadis inspicimus, facile erat cernere,*" as he remarks. He refers to the statement of Herodotus[3] concerning the presence of marine shells in the hills of Egypt and over the Libyan desert, from which the Greek geographer had inferred that the sea formerly covered that whole region; and a like explanation is applied by him to Calabria.

According to Brocchi and Lyell, both of whom have furnished excellent accounts of the development of geological science in Italy, Alessandro anticipated by a long interval the theory advanced by Burnet and Whiston in England, which explained the waters formerly covering the land as having been drawn off in consequence of a change in the inclination of the earth's axis of rotation. But such a theory implies an understanding of the Copernican cosmogony, which Alessandro certainly did not possess, and as no such suggestion as is attributed to him can be found in the *Dies Geniales*, the statement is probably an error. Nevertheless, Alessandro is deserving of credit for having recognized the true nature of fossils, in despite of the popular notions that they were relics of the Scriptural deluge, or sports of nature generated within the solid rock through the operation of some occult force, or through the fermentation of a *materia pinguis*.

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[1] Brocchi, G., Discorso sui progressi dello studio della conchiologia fossile in Italia, prefixed to his *Conchiologia Fossile Subappenina*, Vol. I. p. iv. Milan, 1814. Other early references to petrifactions are given by G. Lami in his Hodoeporicon of Chariton and Hippophilus (Deliciae Eruditorum, Vol. X., p. 43, *passim*). Florence, 1741.

[2] Alexandri ab Alexandro, Genialium Dierum, libri sex. There is a Paris edition of 1589, and a Leyden edition of 1673, in two volumes.

[3] History, Lib. II. cap. xiii.

Throughout the sixteenth and seventeenth centuries the nature and origin of fossils remained a favorite topic of discussion. In the frequent and often vexed disputes of this period are to be observed on the one hand the influence of ecclesiastical prejudice, the Church claiming ability to explain all things, and possessing means of proved efficacy for compelling the acceptance of her views; and on the other hand the persistency of Aristotelian doctrines mingled with rank superstition. Such was the infertile soil into which the method of experiment and observation endeavored to send its roots. A tender plant in the beginning, its first green leaves withered, and during the long warfare between science and theology its growth was retarded. Concerning the methods in vogue during the period we are considering, it has been aptly remarked by Lyell[1] that "the system of scholastic disputations encouraged in the Universities of the middle ages had unfortunately trained men to habits of indefinite argumentation, and they often preferred absurd and extravagant propositions, because greater skill was required to maintain them; the end and object of these intellectual combats being victory and not truth. No theory could be so far-fetched or fantastical as not to attract some followers, provided it fell in with popular notions."

In the midst of such conditions as these it is pleasing to note the appearance of two men of remarkable insight, whose vision was in no wise clouded by the prevailing atmosphere of superstition and dogmatism. The first whom we have to consider is that versatile and brilliant genius, Leonardo da Vinci (1452–1519), of whom Humboldt remarked that "he was the first to start on the road towards the point where all the impressions of our senses convey the idea of the Unity of Nature." His clear exposition of the manner in which fossils have become preserved in the rocks offers a refreshing contrast to the prevailing views of the age, and although noticed by Humboldt,[2] Lyell and others, his remarks have not attracted the attention amongst geologists and palaeontologists which they deserve. An idea may be formed of the nature of his observations from the following extracts, translated literally from his published manuscripts: —

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[1] Lyell, C., Principles of Geology, I. chap. iii. London, 1834.

[2] Humboldt, A. von, Cosmos, II. chap. viii. Stuttgart, 1845.—Libri, G., Histoire des sciences mathématiques en Italie, III. Paris, 1840.—Lyell, C., Principles of Geology, I. chap. iii. London, 1830.—Raab, F., Leonardo da Vinci als Naturforscher, in Virchow and Holtzendorff's Sammlung gemeinverständl. Vorträge, ser. 15, p. 504. Berlin, 1880.—Ravaison-Mollien, C., Les manuscrits de Léonard de Vinci. Manuscrits *F* et *I* de la Bibliothèque de l'Institut. Paris, 1889.—Richter,

"All marine clays still contain shells, and the shells are petrified together with the clay. From their firmness and unity some persons will have it that these animals were carried up to places remote from the sea by the deluge. Another set of ignorant persons declare that Nature or Heaven created them in these places by celestial influences, as if in these places we did not also find the bones of fishes which have taken a long time to grow; and as if we could not count, in the shells of cockles and snails, the periods of their growth, as we do in the horns of bulls and oxen." — *Leic. MS.* 10 *a.*

"And if you were to say that these shells were created, and were continually being created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a brain of much reason; because here we find [lines denoting] annual growth numbered on their shells, and there are large and small shells to be seen which could not have grown without food, and could not have fed without motion, — and here they could not move." — *Leic. MS.* 9 *b.*

"As to those who say that shells existed for a long time and were formed at a distance from the sea from the nature of the place and of the cycles, which can influence a place to produce such creatures, — to them it must be answered: such an influence could not place the animals all on one level, except those of the same sort and age; and not the old with the young, nor some with an operculum and others without their operculum, nor some broken and others whole, nor some filled with sea-sand and large and small fragments of other shells inside the whole shell, which remained open; nor the claws of crabs without the rest of their bodies, nor the shells of other species adhering to them like animals which have moved about on them, since the impressions of their tracks still remain on the outside, after the manner of worms in the wood which they ate into. Nor would there be found among them the bones and teeth of fish which some call arrows and others serpents' tongues, nor would so many portions of various animals be found all together if they had not been thrown on the sea-shore." — *Leic. MS.* 9 *a.*

J. P., The Literary Works of Leonardo da Vinci, compiled and edited from the original manuscripts, II. chap. vi. London, 1883. — Uzzielli, G., Leonardo da Vinci e le Alpi. Turin, 1890. — Venturi, G. B., Essai sur les ouvrages physico-mathématiques de Léonard de Vinci. Paris, 1797. — Whewell, W., History of the Inductive Sciences, II. London, 1847. — White, A.D., History of the Warfare of Science with Theology, I. New York, 1896. The most sumptuously published of all Leonardo's writings is the *Codex Atlanticus* of the Ambrosian library in Milan, which has recently been reproduced in facsimile under the auspices of the Regia Accademia dei Lincei.

"*On Shells in the Mountains.* — And if you were to say that Nature has formed the shells in the mountains through the agency of the constellations, how will you explain it that the constellations create shells of divers species and of different ages in the selfsame spots? . . .

"*On Leaves.* — How will you explain the multitudinous leaves of different species solidified in the rocks high up in the mountains, and sea-weed commingled with shells and sand? And likewise you will see all [sorts of] petrifactions together with fragments of marine crabs, commingled with these shells." — *MS. F, folio* 80, *a, b* (*circa* 1510).

With the exception of the last fragment, which has been inaccurately paraphrased by Venturi, Lyell, and others, the above passages have not been noticed in geological literature. How far Leonardo's ideas are reflected by the commonly current paraphrase referred to may be seen on comparing it with the original text, a literal transcript of which follows: —

"*Denichi nemonti.*

"Essettu vorai dire linichi esserprodutti dalla natura inessi monti mediante leconstelatione per qual uia mosterai tal constellatione fare li nichi di uarie grandeze i eddi uerse eta edi uarie spetie nun medismo sito ——

"*Delle fogle.*

"Cone [Come] proverrai ilgrandissimo numero di uarie spetie di foglie congelata nellei *pietre* alti sassi di tal monti ellaligha erba dimare stande a diacere mista con nichi ecosiuderi onni cosa petrificato insieme congranche marini rotti inpezi etramezati tu essi nichi."

The second notable sixteenth-century personage whose opinions concern us is Girolamo Fracastoro, or in the more usual scholastic form, Hieronymus Fracastorius (1483–1553) of Verona, famous as physician, poet, and astronomer. A statue erected to his memory a few years after his decease attests the esteem in which he was held by his fellow-townsmen, and the eulogies pronounced upon him in foreign lands indicate a widespread recognition of his ability. Through the partiality of an enthusiastic fellow-countryman,[1] he has been allotted little short of an apotheosis, but the most trustworthy judgment is probably that of Libri, which is as follows: "Un seul nom, celui de Fracastoro, domine à présent les noms de tous ces astronomes italiens. Il fut célèbre par la profondeur et la variété de ses connaissances. De Thou, qui, dans son histoire, en a fait un magnifique éloge, dit que Sannazar s'avoua vaincu par les vers latins du médecin de Vérone. Il fut botaniste, philosophe, et mathématicien, et, cultivant des sciences si diverses, il s'illustra dans toutes."[1]

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[1] Lioy, P., Linneo, Darwin, Agassiz nella vita intima. Milan, 1904.

Fracastoro resembled his illustrious contemporary Leonardo in his ability to deduce sound conclusions from observed facts, and in his habit of appealing directly to nature rather than to authority for answer to the problems confronting him. His opinions in regard to the nature of fossils, a variety of which were brought to his attention during the reconstruction of a citadel in Verona in 1517, are set forth very clearly in a description of the Calceolarian Museum,[2] a work frequently referred to by the older writers, and also in an historical account of Verona by Torello Saraina.[3] Fracastoro ridicules the notion that fossils are the reliquiae of the Mosaic deluge, or were formed within the rocks through the agency of a plastic force, and states his reasons for believing them to be the remains of plants and animals which inhabited the sea at a period when the continents were submerged. Had these sensible views been heeded, much useless discussion which continued throughout the succeeding two centuries would have been avoided.

A brief notice concerning the fossil fishes of Monte Bolca, the earliest in which they are specifically referred to, was inserted by the celebrated botanist Mattioli[4] in his fourth edition of the *Materia Medica* of Dioscorides, which he commentated and illustrated in 1552. He also quotes the statements of Polybius, in Book XXXIV. of his History, regarding the "subterranean fish" of Narbonne and the views of earlier writers on the nature of fossils in general.

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[1] *Op. cit.*, II. p. 101.

[2] Chiocco, A., and Ceruti, B., Musae m Franc. Calceolari iun. Veronensis. Verona, 1622. The passage entitled "Magni Fracastorii Sententia de proposita quaestione," which occurs on p. 407 of this work, is quoted *in extenso* by Vallisneri in his *De' corpi marini che su' monti si trovano* (Venice, 1721), and is referred to by various other authors prior to Lioy. A figure evidently of *Holocentrum macrocechalum* is given on p. 428 of this work.

[3] Saraina, T., De Origine et Amplitudine Civitatis Veronae. Verona, 1580.

See also on Fracastoro the following: Barbarini, E., Girolamo Fracastoro e le sue opere. Verona, 1894. — Caverni, R., Storia del metodo sperimentale in Italia. Florence, 1893.— Holden, E. S., The Precursors of Copernicus (Pop. Sci. Monthly, LXIV. p. 816), 1904. — Lioy, P., Fracastoro e le sue idee divinatrici della Paleontologia (Atti R. Istit. Veneto, ser. 7, IX. p. 1098), 1898. — Meneghini, G., Dei meriti dei Veniti nelle Geologia. Pisa, 1866. — Menken, O., De vita, moribus, scriptis meritisque H. Fracastori Veronensis. Leipzic, 1731. — Omboni, G., Cenni sulla storia della Geologia. Padua, 1894. — Stoppani, A., Della preminenza e priorità degli studj geologici in Italia. Milan, 1868.

[4] Mattioli, P. A., Commentarii secondo aucti, in libros sex Pedaci Dioscoridis de Medica Materia, 4th ed., Venice, 1552; 5th, *ibid.*, 1558. The reference occurs in the Introduction to Book V., and is wanting in earlier editions of this work.

About this time interest became awakened in the formation of natural history collections, first in Italy, where zoölogical gardens had long since been introduced, and afterwards generally throughout Europe. One of the earliest and at the same time most extensive, was the museum founded at Verona in 1572 by Francesco Calceolari, which contained a number of Bolca fishes, and was the fruitful source of several publications. Ulisse Aldrovandi (1522–1607), a noted scientist and professor at the University of Bologna, brought together a large private collection, out of which grew eventually the Public Museum of Bologna, and descriptions of his minerals and fossils were published some years after his death.[1] In 1574 an elaborate description was prepared by Mercato, but not published until nearly a century and a half later, of the Vatican collection of minerals, fossils, and antiquities which had been brought together under the auspices of Pope Sixtus V. The priestly author, however, was content to believe that not only fossils, but even ancient pottery and inscriptions were mineral concretions which had assumed their shapes through the influence of celestial bodies.[2] Agassiz contemptuously remarks of this work that it is a "compilation sans valeur et sans goût." The physician Olivi of Cremona, who described in 1584 the fossils contained in the Calceolarian Museum,[3] was likewise prejudiced in regarding them as *lusi naturae.* Nevertheless his work was deemed worthy of being reprinted nine years later, and new illustrations of the same museum appeared in 1622, at the hands of Ceruti and Chiocco, as already noted. It is in this work that the opinions of Fracastoro, announced more than a century earlier, are at last accorded recognition. Among the curiosities of palaeontological literature belonging to this period should be mentioned Buonamici's dissertation on *Glossopetrae,*[4] published in 1668.

SEVENTEENTH AND EIGHTEENTH CENTURIES. The important contributions to palaeontology made by Fabius Colonna, Nicolas Steno, and Augustin Scilla during the seventeenth century are well known, hence we may pass over these authors with the bare mention of their names.[1] Throughout this period the growth of museums continued apace, and attempts to describe their fossil contents succeeded better as Fracastoro's ideas were revived and gradually gained acceptance. Descriptions appeared of the Aldrovandi collection in 1648, as has been stated, and in 1656 of Count Moscardo's[2] museum in Verona, both of which contained interesting fish remains. Another museum famous for its fossils was that of Zannichelli[3] of Venice, who prepared an elaborate catalogue of its contents, published first in 1720, with additions in 1736. Attention should also be called to the important essay by Vallisneri[4] "*On Marine Bodies found in the Mountains*," published in 1721, in which reference is made to the fishes and crustaceans occurring at Monte Bolca. Appended to the complete works of this author is a letter on Bolca fishes, with a map of the locality, by Ferdinand Marsili.[5]

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[1] Ambrosini, Musaeum metallicum. 1648.

[2] Mercato, M., Metallotheca [Vaticana], opus posthumum. Rome, 1717.

[3] Olivi, G. B., De recondites et praecipius collectaneis a Francesco Calceolario Veronensis, in Museo adservatis. Verona, 1584; and Venice, 1593.

[4] Buonamici, F., Sulle glossopetre, gli occhi di serpe ed altre pietre, etc. (Opusc. Sicil. Vol. XII.), 1668. References to other essays of this period on the same subject will be found in Palaeontographica, XLI. pp. 149–153, 1895.

As remarked by Lyell, the writings of Vallisneri are rich in geological observations. He attempted the first general sketch of the marine deposits of Italy, their geographical extent and most characteristic organic remains, and was the principal opponent amongst his countrymen of Woodward's diluvian hypothesis. In 1702 the fossil fishes of Monte Bolca were made the subject of a communication before the French Academy by Maraldi,[6] an Italian astronomer, and the same body was similarly addressed by J. J. Scheuchzer, whose "*Piscium querelae et vindiciae*" and other writings provoked wide-spread discussion. Notices of vertebrate remains appear also in the dissertations of Spada,[7] a learned priest of Grezzana, who wrote in 1737, and again in 1744, to prove that the fossils found near Verona were not of diluvian origin. Scipio Maffei[1] was another active collector and writer on Bolca fishes during the middle of the eighteenth century. But we cannot dwell upon any of the numerous minor publications of this time, nor even upon the more important contributions of Moro,[2] Generelli,[3] and others. With this brief sketch we must conclude our survey of pre-Linnaean literature, and pass on to the modern era; for from the time of the two great Swedish naturalists onward, Linné and Artedi, the latter of whom is justly styled the "father of ichthyology," a new order of things existed.

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[1] On these writers one may consult the following: Seguenza, G., Agostino Scilla. Messina, 1868.—Marsh, O. C., History and Methods of Palaeontological Discovery (Proc. Amer. Assoc. Adv. Sci. 1879), 1880.—Ward, L. F., Sketch of Palaeobotany, Fifth Ann. Rept. U. S. Geol. Surv. (1883-1884), 1885.—Zittel, K. A., Geschichte der Geologie und Paläontologie. Munich, 1899.

[2] Note overo memorie del Museo di Lodovico Moscardo, dal medesimo descritte. Padua, 1656. Some poor figures of Bolca fishes are given on p. 182.

[3] Zannichelli, Apparatus rariorum Musaei Zannicchelli. Venice, 1720. *Idem*, Enumeratio rerum naturalium Musaei Zannichelli. Venice, 1736. This catalogue contains the earliest mention of fossil hippopotami in Italy.

[4] Vallisneri, A., De' corpi marini che su' monti si trovano. Venice, 1721.

[5] Vallisneri, A., Opere, II. p. 359.

[6] Maraldi, J. P., Diverses observations de physique génerale, § xi. (Hist. Acad. Roy. Sci., année 1703). Paris, 1720. This is the earliest communication on Bolca fishes published by any learned society. The earliest in English is a paper by G. Graydon, entitled "On the fish enclosed in stone of Monte Bolca," which appears in the transactions of the Royal Irish Academy for 1794 (Vol. V., p. 281).

[7] Spada, J. J., Dissertazione ove si prova che i corpi marini petrificati non sono

One of the earliest writers of the new era in natural science, and indeed the first who attempted a specific determination of the Bolca fishes, was Cammillo Zampieri d'Imola,[4] whose Catalogue of the Ginanni Museum, published in 1762, is decidedly meritorious. His identification of species, however, based as it was upon the treatises of Willoughby and Ray, was altogether faulty. The celebrated Fortis also made unsuccessful endeavors to identify Bolca fishes with the species described by Bloch and Broussonet. Fortis had already noted the occurrence of fossil fishes[5] in other parts of the Alpine strata, but on turning his attention to the Bolca forms, he encountered difficulties.[6] He was mis-

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diluviani. Verona, 1737. — *Idem*, Corporum lapidefactorum agri veronensis catalogus. Verona, 1744. In Plate ii. of this work is given a tolerable figure of *Semiophorus*. See also Cobres's estimate of Spada, in Büchersammlung der Naturgeschichte, I. p. 20.

[1] Maffei, F. S., Del Monte Bolca, della sua Pesciaia, e degli annessi Monti Calonnari, etc., in his *Compendio della Verona Illustrata*, Vol. I., pp. 217–230, pl. i.–viii. Verona, 1795.

[2] Moro, L., Sui crostacei ed altri corpi marini che si trovano sui monti. 1740. The same work was also published in German under the title of "Neue Untersuchungen über die Abänderungen der Erde." Leipzic, 1751.

Moro's ideas were appropriated without acknowledgment by Edward King in a paper read before the Royal Society entitled "An attempt to account for the Universal Deluge" (Phil. Trans., LVII. pp. 44–57), 1767. For a biographical sketch of Lazzaro Moro see Giornale di Storia naturale del Griselini, I. p. 79.

[3] Generelli, C., Dei crostacei e di altre produzione del mare. 1749.

[4] Zampieri, C., Produzione naturali che si ritrovano nel Museo Ginanni in Ravenna. Lucca, 1762.

[5] Fortis, A., Viaggi in Dalmazia, II. p. 239. 1774.

[6] Fortis, A., Extrait d'une lettre, etc. Journ. de Phys., XXVIII. 1786. In a later communication to the same journal, Fortis vigorously disclaims authorship of the catalogue of Bolca fishes which is appended to his first article. In this anonymous postscript an extravagant valuation (28,000 liv.) is placed upon the Bozza Collection, which then consisted of about six hundred specimens.

led into supposing certain species to be identical with modern tropical forms, and his somewhat fanciful theories to explain their occurrence in northern Italy plunged him into a spirited controversy with another prominent naturalist, Domenica Testa. Their letters, written in a style that is both elegant and incisive, show wide erudition and good argumentative ability on both sides. The correspondence was finally collected and published in book form, with comments of his own, by Count Giambattista Gazola[1] of Verona, in 1793 and 1794.

By this time a very lively interest had arisen in regard to the fishes of Monte Bolca, and the Veronese collections became greatly augmented as the result of excavations that had been undertaken on purpose to secure them. The culmination of this activity was marked by the appearance in 1796 of an elaborate work by G. Serafino Volta, entitled *Ittiolitologia Veronese.* In the compilation of this famous monograph, which was illustrated by nearly fourscore excellent plates, Volta was aided by several collaborators, chief amongst whom was Count Gazola himself. Volta had already published in 1789 a list of the fossil fishes occurring at Monte Bolca,[2] in which about one hundred species were enumerated, and of these twenty-five were erroneously identified with recent forms. The determinations in his final memoir were scarcely more fortunate, Agassiz having afterwards declared that there was only one[3] adequately established species in the whole work, that one being *Blochius longirostris.* The practical value of Volta's work, however, was immeasurably increased by the redetermination of his originals, an authentic list of the figured specimens being published by Agassiz[4] in 1833. In this list Volta's originals are regarded as belonging to 90 species and 69 genera, all of the species being marine, and none of them represented in the existing fauna.

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[1] Gazola, G., Lettere recentemente pubblicate sui pesci fossili veronesi, con annotazioni inediti agli estratti delle medesime. Milan, 1793, and Verona, 1794.

[2] Volta, G. S., Degl' impietrimenti del Territorio Veronese, etc. Lettera al Sig. Vincenzo Bozza, 1789. *Idem*, Prospetto del Museo Bellisomi. 1787.

[3] This is not strictly true. The names of over a dozen species described by Volta as new are rejected by Agassiz, and others substituted, for the reason that the forms were regarded in the first instance as belonging to existing genera. A list of the species which should properly be credited to Volta is as follows:

Blochius longirostris, Eocottus veronensis, Ephippus asper, Ductor vestenae, Mene rhombeus, Monopterus gigas, Platax papilio, Pygaeus bolcanus, Pycnodus apodus, Rhamphosus rastrum, Rhinellus lesiniformis, Semiophorus velifer, Vomeropsis triurus, Xiphopterus falcatus.

[4] Agassiz, L., Revue critique des Poissons Fossiles figurés dans l'Ittiolitologia Veronese. Neuchâtel, 183[illegible]. Also in German in the Neues Jahrbuch for 1835.
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Volta narrates in considerable detail the history of the principal collections which furnished him with material. Of these there were ten belonging to Veronese gentlemen, the most notable one being the property of Count Gazola, with which the Bozza and Dionisi collections became shortly afterwards united. The circumstances which deprived Count Gazola of most of his specimens in 1797, their removal to Paris by order of First Consul Bonaparte, and their presentation by him to the Museum of Natural History in that city are familiar historical facts.

The second largest suite of fossil fishes was that belonging to the Marchese Ottavio di Canossa, which afterwards became enlarged by the purchase of Julius Cæsar Moreni's collection. Agassiz never had access to the Canossa Collection, nor in fact to any in Italy, but portions of it were described by subsequent authors at various times. The collection remained intact at Verona until 1903, when it passed into the possession of natural history dealers and museums of several countries. Heckel's figured specimen of *Palaeobalistum orbiculatum*, for instance, was acquired by the British Museum, Massalongo's types of *Archiophis* were divided between the Harvard and Berlin Museums, and the Carnegie Museum at Pittsburg also obtained several of Massalongo's figured specimens.

Count Gazola's first care on suffering the loss of his splendid collection was to undertake the formation of a new one. Excavations at Bolca were recommenced, and on the death of Count Ronconi a number of fine specimens which he had brought together passed into Gazola's hands; the result of all this activity being that, phoenix-like, his museum became speedily rehabilitated. This second collection of Count Gazola is preserved in the Museo Civico of Verona, but is not now, and unfortunately never has been, fully accessible for study. The scientific value of this collection was fully appreciated by Jacob Heckel, who first visited it in 1850. The condition in which he found the museums of Verona, Padua, Venice, and other cities at that time is set forth by him in a highly entertaining narrative which he communicated to the Vienna Academy,[1] under whose patronage the journey was undertaken. In referring to the Gazola Collection, he laments particularly the fact that it never came under Agassiz's observation, for this "heerliches Material," as he calls it, would have helped him to a much more complete understanding of many interesting species, and even genera, and would have enriched our knowledge of the Bolca fauna with valuable details.

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[1] Heckel, J., Bericht über eine Reise, etc. (Sitzungsber Akad. Wissensch. Wien, VII. p. 318), 1851.

Heckel also remarks that the same collection "ist bei weitem reicher als jene des Marchese Canossa und liefert eine beinahe vollständige Uebersicht sämmtlicher organischer Reste, welche in den tertiären Ablagerungen des Monte Bolca enthalten sind."

The only other private collection which we need notice here is that brought together early in the nineteenth century by Luigi Castellini, of Castelgomberto, which now forms one of the principal treasures of the Padua Museum. This comprised in all about five hundred fishes from Monte Bolca and Monte Postale, some of which were remarkable for their large size and excellent preservation, as well as for their rarity. "Sie ist auf drei grossen Doppelpulten aufgestellt," writes Heckel in his naïve narrative of 1850, "und enthält ausser vielen der seltenen Arten und manchen Prachtstücke, sämmtliche in Doppelplatten, auch einige bisher unbeschriebene Species, deren nähere Bekanntschaft mich um so angenehmer berührte, da ich bereits mehrere derselben zu Verona in der schönen Sammlung des Herrn Grafen Gazola unter Glas bemerkt hatte." Some of these new forms were shortly afterwards described by Heckel, and others have been investigated by more recent writers.

We return now to the first Gazola Collection, which, as we have seen, was transported to Paris in 1797, and deposited in the Museum of Natural History. It is well known that Cuvier spent considerable time in the investigation of this material, with the intention of preparing a monograph upon it,— a task, however, which was ceded finally to Agassiz. Some use of the collection was made by de Blainville in the preparation of his article [1] on fossil fishes, published in 1818, but it cannot be said that our knowledge was materially increased by this author. It remained for the elder Agassiz, in 1831 and 1832, to ascertain the true nature of the extinct forms of fish life here represented, and by means of this and other collections which he studied, to give the first accurate and best general account we possess of the remarkable ichthyic fauna occurring at Monte Bolca.

Agassiz's own estimate of the value of the Gazola Collection is thus expressed by him: "Le Muséum d'Histoire Naturelle de Paris a été pour moi l'une des mines les plus riches que j'aie exploitée. . . . La collection de poissons fossiles la plus importante qui existe maintenant, et en même temps qui offre le plus d'intérêt historique, est, sans contredit, celle du comte de Gazola, qui a fourni les originaux pour l'*Ittiolitologia Veronese*. . . . Je l'ai entièrement revue et complètement décrite vers la fin de 1831 et pendant les huit premiers mois de l'année 1832, et j'ai inscrit mes déterminations sur le revers de toutes les plaques." [1]

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[1] De Blainville, H. D., Sur les Ichthyolites, ou les Poissons Fossiles, in his Nouveau Dictionnaire d'Histoire Naturelle, Vol. XXVIII. Paris, 1818.

The total number of species recognized by Agassiz as the result of his investigations of the Gazola Collection and other Bolca material that came under his observation was 127, and the total number of genera 77. Many of Volta's types were refigured by him, but in several cases descriptions were given without fresh illustration, and in others Volta's figures were merely renamed without further description. Some confusion in the nomenclature was occasioned by reason of other names being applied to species which had been duly established both by Volta and by de Blainville, and in about a dozen instances MS. names were proposed for certain forms which up to the present time have remained undescribed. These *types inédits*, designated as such in Agassiz's handwriting, have recently been investigated by the present writer, and their publication undertaken by the French Geological Society. It must not be supposed, however, that all of Volta's types which originally formed part of the Gazola Collection are now preserved in the Paris Museum, nor was it possible even in Agassiz's time to account for the specimens which were then missing.[2] Owing to the historic and scientific interest attaching to these originals, it is to be hoped that all such as are still in existence and have escaped notice amongst other collections may again come to light. Lists are given below of all the types and hypotypes belonging to the Gazola Collection in Paris.

It will be sufficient to pass over the post-Agassizian literature of the Bolca fish-fauna very briefly, merely indicating the names of the principal contributors. These are, in chronological order, Jacob Heckel, Rudolf Kner, Franz Steindachner, Raffaele Molin, Abramo Massalongo, Paolo Lioy, Achille de Zigno, Francesco Bassani, Wladislaw Szajnocha,

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[1] Agassiz, L., Poissons Fossiles, I. p. 5. Neuchâtel, 1833.

[2] The Library of the Museum of Comparative Zoölogy possesses the identical copy of Volta's work employed by Professor Agassiz in his determinations of the types in the Gazola Collection at Paris. Each figure of the plates is marked with Agassiz's revised designation, and in cases where the originals were wanting, the fact is so indicated. His private copy of de Blainville's *Poissons Fossiles*, in the same library, likewise contains valuable corrections and annotations. The Museum has received through Prof. R. T. Jackson, who obtained it from Prof. J. E. Wolff, a specimen which formerly belonged to the Gazola Collection at Paris, but which disappeared from it probably during some of the early vicissitudes through which the collection passed. Several interesting notices of the latter are to be found in the papers of Faujas-St.-Fond, de Jussieu, Cuvier, and others, published in the early volumes of the *Annales* and of the *Mémoires du Museum d'Histoire Naturelle.*

Carl Gorganovic-Kramberger, Otto Jaekel, and A. Smith Woodward. Some seventy-five additional species have been described by these authors in the aggregate, making a total representation of slightly more than two hundred. A rather considerable number of these, however, are undoubtedly synonyms, and the status of a score or more of imperfectly defined species requires further investigation.

The best general account of the geology of the region in which this fish-fauna occurs is contained in an inaugural dissertation by the late Munier-~~Chalmas~~, entitled "*Étude du Tithonique, du Crétacé et du Tertiaire du Vicentin*" (Paris, 1891), the usefulness of which is increased by a copious bibliography. Mention should also be made of Enrico Nicolis' "*Carta Geologica della Provincia di Verona*" (Verona, 1882), and of his "*Sugli antici Corsi dell' Adige*" (Rome, 1898). The invertebrate fauna of Monte Bolca forms the subject of special memoirs by Cattullo[1] and Oppenheim.[2]

LIST OF SPECIMENS IN THE GAZOLA COLLECTION OF THE PARIS MUSEUM FIGURED IN VOLTA'S "ITTIOLITOLOGIA VERONESE," ARRANGED IN SERIAL ORDER.

VOLTA (*Itt. Ver.*).		REFIGURED BY AGASSIZ (*Poissons Fossiles*).
Pl. 3, Fig. 1.	*Carcharias* (*Scoliodon*) *cuvieri* (Ag.).	
4.	*Platax pinnatiformis* (Blv.).	Vol. IV. Pl. 41.
5, " 1.	*Aulostoma bolcense* (Blv.).	Vol. IV. Pl. 35, Fig. 3.
5, " 2.	*Fistularia longirostris* (Blv.).	Vol. IV. Pl. 35, Fig. 4.
5, " 3.	*Calamostoma breviculum* (Blv.).	Vol. II. Pl. 74, Fig. 1.
5, " 4.	*Rhamphosus rastrum* (Volta).	Vol. IV. Pl. 32, Fig. 7.
7, " 1.	*Semiophorus velifer* (Volta).	Vol. IV. Pl. 37 *a*, Fig. 2.
7, " 2.	" " "	Vol. IV. Pl. 37 *a*, Fig. 1.
7, " 3.	" *velicans* (Blv.).	Vol. IV. Pl. 37.
8, " 1.	*Pomacanthus subarcuatus* (Blv.).	Vol. IV. Pl. 19, Fig. 2.
9, Figs. 1, 2.	*Trygon muricatus* (Volta).	
10, Fig. 1.	*Ephippus rhombus* (Blv.).	
11, " 1.	*Eocottus veronensis* (Volta).	Vol. IV. Pl. 34, Fig. 3.
11, " 2.	" " "	Vol. IV. Pl. 34, Fig. 4.
12, " 1.	*Blochius longirostris* Volta.	Vol. II. Pl. 44, Fig. 3.
12. " 2.	" " "	

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[1] Cattullo, T. A., Memorie sopra li corpi organizzati fossili del Bolca, etc. (Giornale di Pavia), 1818–22.

[2] Oppenheim, P., Die Eocänfauna des Monte Postale bei Bolca in Veronesischen (Palaeontographica, XLIII. pp. 125–222), 1896.

VOLTA (*Itt. Ver.*).		REFIGURED BY AGASSIZ (*Poissons Fossiles*).
Pl. 13, Fig. 1.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 29, Fig. 2.
13, " 2.	*Spinacanthus cuneiformis* (Blv.).	Vol. V. Pl. 39, Fig. 1.
14, " 1.	*Enoplosus pygopterus* Ag.	Vol. IV. Pl. 9, Fig. 1.
17, " 1.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 29, Fig. 2.
17, " 3.	*Lates gracilis* Ag.	Vol. IV. Pl. 3, Fig. 2.
19.	*Acanthonemus subaureus* (Blv.).	Vol. V. Pl. 4.
20, " 1.	*Ephippus asper* (Volta).	
20, " 2.	*Pristigenys substriatus* (Blv.).	
22, " 1.	*Naseus nuchalis* Ag.	Vol. IV. Pl. 36, Fig. 2.
23, " 1.	*Ophisurus acuticaudus* Ag.	
23, " 3.	*Anguilla leptoptera* Ag.	
24, " 3.	*Rhamphognathus sphyraenoides* (Ag.).	Vol. V. Pl. 38, Fig. 2.
25, " 1.	*Chanoides macropoma* (Ag.).	
25, " 2.	" " "	Vol. V. Pl. 37 *b*, Fig. 4.
26, " 1.	*Platax papilio* (Volta).	Vol. IV. Pl. 42.
26, " 2.	*Zanclus brevirostris* Ag.	Vol. IV. Pl. 38, Figs. 1, 2.
27.	*Thynnus* (?) *bolcensis* Ag.	
29, " 1.	" *lanceolatus* (Ag.).	
29, " 4.	*Urosphen dubia* (Blv.).	
30.	*Callipteryx recticaudus* Ag.	Vol. IV. Pl. 33, Fig. 2.
31, " 1.	*Sparnodus elongatus* Ag.	Vol. IV. Pl. 28, Fig. 1.
31, " 2.	*Acanthurus tenuis* Ag.	Vol. IV. Pl. 36, Fig. 1.
32, " 1.	*Sparnodus elongatus* Ag.	Vol. IV. Pl. 23 *b*, *infra*.
32, " 2.	*Ductor vestenae* (Volta).	Vol. V. Pl. 12.
33.	*Naseus rectifrons* Ag.	Vol. IV. Pl. 36, Fig. 3.
35, " 1.	*Pycnodus apodus* (Volta).	
35, " 3.	*Vomeropsis triurus* (Volta).	Vol. V. Pl. 5.
35, " 4.	*Cyclopoma* (?) *micracanthum* (Ag.).	
37.	*Labrus valenciennesi* Ag.	Vol. V. Pl. 39, Fig. 2.
38, " 1.	*Paranguilla tigrina* (Ag.).	Vol. V. Pl. 49.
39, " 3.	*Trachynotus tenuiceps* Ag.	Vol. V. Pl. 7, Figs. 1, 2.
39, " 5.	*Engraulis evolans* (Ag.).	Vol. V. Pl. 37 *b*, Figs. 1, 2.
40.	*Palaeobalistum orbiculatum* (Blv.).	
42, " 1.	*Ostracion dubius* (Blv.).	Vol. II. Pl. 74, Figs. 4, 5.
42, " 2.	"*Pegasus volans*" Linn. (indeterminable).	
42, " 3.	*Lophius brachysomus* Ag.	Vol. V. Pl. 40, Figs. 1, 2.
44, " 1.	*Amphistium paradoxum* Ag.	
44, " 2.	*Vomeropsis triurus* (Volta).	Vol. V. Pl. 6.
45, " 1.	*Toxotes antiquus* Ag.	Vol. IV. Pl. 43.
45, " 2.	*Dules temnopterus* Ag.	Vol. IV. Pl. 21, Figs. 1, 2.
45, " 3.	*Sparnodus microstomus* (Ag.).	
47.	*Monopterus gigas* Volta.	
48, " 3.	*Atherina macrocephala* Ag.	

VOLTA (*Itt. Ver.*).		REFIGURED BY AGASSIZ (*Poissons Fossiles*).
Pl. 51, Fig. 2.	*Holocentrum macrocephalum* Blv.	Vol. IV. Pl. 14.
51, " 3.	*Acanthonemus subaureus* (Blv.).	Vol. V. Pl. 3.
53, " 2.	*Leptocephalus medius* Ag.	
54.	*Dentex leptacanthus* Ag.	Vol. IV. Pl. 26.
55, " 1.	*Blochius longirostris* Volta. (The head of an anguilliform fish has been substituted for the one properly belonging to this specimen.)	
55, " 2.	*Orycynus latior* Ag.	Vol. V. Pl. 24.
56, " 2.	*Apogon spinosus* Ag.	Vol. IV. Pl. 9, Figs. 2, 3.
56, " 3.	*Cyclopoma* (?) *micracanthum* (Ag.).	
57.	*Xiphopterus falcatus* (Volta).	
58, " 1.	*Pseudosyngnathus opisthopterus* (Ag.).	
58, " 2.	*Ductor vestenae* (Volta).	
59.	*Pygaeus bolcanus* (Volta).	Vol. IV. Pl. 20.
60, " 2.	*Sparnodus vulgaris* (Blv.).	Vol. IV. Pl. 28, Fig. 3.
61.	*Platyrhina gigantea* (Blv.).	
62.	*Sphyraena bolcense* Ag.	
69, " 1.	*Seriola analis* Ag.	
70.	*Blochius longirostris* Volta.	
72, " 1.	*Holocentrum macrocephalum* Blv.	
72, " 4.	*Myripristis homopterygius* Ag.	
73.	*Sparnodus vulgaris* (Blv.).	
74.	*Cyclopoma gigas* Ag.	
75, " 1.	*Rhamphosus rastrum* (Volta).	
76.	*Cyclopoma spinosum* Ag.	

ALPHABETICAL LIST OF THE TYPE AND FIGURED SPECIMENS OF BOLCA FISHES BELONGING TO THE GAZOLA COLLECTION, NOW PRESERVED IN THE PARIS MUSEUM OF NATURAL HISTORY.

1.	*Acanthonemus subaureus* (Blv.).	Volta, Pl. 51, Fig. 3; Ag., V. Pl. 3.
2.	" " "	Volta, Pl. 19; Ag., V. Pl. 4.
3.	*Acanthurus tenuis* Ag.	Volta, Pl. 31, Fig. 2; Ag., IV. Pl. 36, Fig. 1.
4.	*Amphistium paradoxum* Ag.	Volta, Pl. 44, Fig. 1.
5.	" "	Ag., V. Pl. 13.
6.	*Anguilla branchiostegalis* Ag. (MS.).	
7.	" *brevicula* Ag.	Ag., V. Pl. 43, Fig. 1.
8.	" *leptoptera* Ag.	Volta, Pl. 23, Fig. 3.
9.	*Apogon spinosus* Ag.	Volta, Pl. 56, Fig. 2; Ag., IV. Pl. 9, Figs. 2, 3.
10.	*Atherina macrocephala* Ag.	Volta, Pl. 48, Fig. 3.

11.	*Aulostoma bolcense* (Blv.).	Volta, Pl. 5, Fig. 1; Ag., IV. Pl. 35, Fig. 3.
12.	“ “ “	Ag., IV. Pl. 35, Fig. 2.
13.	*Blochius longirostris* Volta.	Volta, Pl. 12, Fig. 1; Ag., II. Pl. 44, Fig. 3.
14.	“ “ “	Volta, Pl. 12, Fig. 2.
15.	“ “ “	Volta, Pl. 55, Fig. 1.
16.	“ “ “	Volta, Pl. 70.
17.	*Calamostoma breviculum* (Blv.).	Volta, Pl. 5, Fig. 3; Ag., II. Pl. 74, Fig. 1.
18.	*Callipteryx recticaudus* Ag.	Volta, Pl. 30; Ag., IV. Pl. 33, Fig. 2.
19.	“ *speciosus* Ag.	Ag., IV. Pl. 33, Fig. 1.
20.	*Carangopsis dorsalis* Ag.	Ag., V. Pl. 8.
21.	*Carcharias* (*Scoliodon*) *cuvieri* (Ag.).	Volta, Pl. 3, Fig. 1.
22.	*Chanoides leptostea* Ag. (MS.).	
23.	“ *macropoma* (Ag.).	Volta, Pl. 25, Fig. 1.
24.	“ “ “	Volta, Pl. 25, Fig. 2; Ag., V. Pl. 37 *b*, Fig. 4.
25.	*Coelogaster analis* Ag. (MS.).	
26.	*Cybium speciosum* Ag.	Ag., V. Pl. 25.
27.	*Cyclopoma gigas* Ag.	Ag., IV. Pl. 2.
28.	“ “ “	Volta, Pl. 74.
29.	“ (?) *micracanthum* (Ag.).	Volta, Pl. 35, Fig. 4.
30.	“ *spinosum* Ag.	Volta, Pl. 76.
31.	“ “ “	Ag., IV. Pl. 1.
32.	*Dentex crassispinus* Ag.	
33.	“ *leptacanthus* Ag.	Volta, Pl. 54; Ag., IV. Pl. 26.
34.	*Ductor vestenae* (Volta).	Volta, Pl. 32, Fig. 2; Ag., V. Pl. 12.
35.	“ “ “	Volta, Pl. 58, Fig. 2.
36.	*Dules temnopterus* Ag.	Volta, Pl. 45, Fig. 2; Ag., IV. Pl. 21, Figs. 1, 2.
37.	*Engraulis evolans* Ag.	Volta, Pl. 39, Fig. 5; Ag., V. Pl. 37 *b*, Figs. 1, 2.
38.	*Enoplosus pygopterus* Ag.	Volta, Pl. 14, Fig. 1; Ag., IV. Pl. 9, Fig. 1.
39.	*Eomyrus formosissimus* (Ag.) (MS.).	
40.	“ *interspinalis* “ “	
41.	“ *latispinus* (Ag.).	Ag., V. Pl. 43, Fig. 4.
42.	*Eocottus veronensis* (Volta).	Volta, Pl. 11, Fig. 1; Ag., IV. Pl. 34, Fig. 3.
43.	“ “ “	Volta, Pl. 11, Fig. 2; Ag., IV. Pl. 34, Fig. 4.
44.	*Ephippus asper* (Volta).	Volta, Pl. 20, Fig. 1.
45.	“ “ “	Ag., IV. Pl. 39, Fig. 3.
46.	“ *rhombus* (Blv.).	Volta, Pl. 10, Fig. 1.

47.	*Ephippus rhombus* (Blv.).	Ag., IV. Pl. 40.
48.	*Fistularia longirostris* (Blv.).	Volta, Pl. 5, Fig. 2; Ag., IV. Pl. 35, Fig. 4.
49.	*Holocentrum macrocephalum* Blv.	Volta, Pl. 51, Fig. 2; Ag., IV. Pl. 14.
50.	" " "	Volta, Pl. 72, Fig. 1.
51.	" *pygmaeum* Ag.	Ag., IV. Pl. 15, Fig. 1.
52.	*Holosteus esocinus* Ag.	Ag., V. Pl. 43, Fig. 5.
53.	*Labrax schizurus* Ag.	Ag., IV. Pl. 13, Fig. 3.
54.	*Labrus valenciennesi* Ag.	Volta, Pl. 37; Ag., V. Pl. 39, Fig. 2.
55.	*Lates gracilis* Ag.	Volta, Pl. 17, Fig. 3; Ag., IV. Pl. 3, Fig. 2.
56.	" " "	Ag., IV. Pl. 5.
57.	*Leptocephalus medius* Ag.	Volta, Pl. 53, Fig. 2.
58.	*Lophius brachysomus* Ag.	Volta, Pl. 42, Fig. 3; Ag., V. Pl. 40, Figs. 1, 2.
59.	" " "	Ag., V. Pl. 40, Figs. 3, 4.
60.	*Mene oblongus* (Ag.).	Ag., V. Pl. 1, Figs. 1, 2.
61.	*Monopterus gigas* Volta.	Volta, Pl. 47.
62.	*Myripristis homopterygius* Ag.	Volta, Pl. 72, Fig. 4.
63.	*Naseus nuchalis* Ag.	Volta, Pl. 22, Fig. 1; Ag., IV. Pl. 36, Fig. 2.
64.	" *rectifrons* Ag.	Volta, Pl. 33; Ag., IV. Pl. 36, Fig. 3.
65.	*Odonteus sparoides* Ag.	Ag., IV. Pl. 39, Fig. 2.
66.	*Ophisurus acuticaudus* Ag.	Ag., V. Pl. 23, Fig. 1.
67.	*Orycynus latior* Ag.	Volta, Pl. 55, Fig. 2; Ag., V. Pl. 24.
68.	*Ostracion dubius* (Blv.).	Volta, Pl. 42, Fig. 1; Ag., II. Pl. 74, Figs. 4, 5.
69.	*Pagellus microdon* Ag.	Ag., IV. Pl. 27, Fig. 1.
70.	*Palaeobalistum orbiculatum* (Blv.).	Volta, Pl. 40.
71.	*Paranguilla tigrina* (Ag.).[1]	Volta, Pl. 38, Fig. 1; Ag., V. Pl. 49.
72.	"*Pegasus volans*" Linn.	Volta, Pl. 42, Fig. 2.
73.	*Pelates quindecimalis* Ag.	Ag., IV. Pl. 22.
74.	*Platax papilio* (Volta).	Volta, Pl. 26, Fig. 1; Ag., IV. Pl. 42.
75.	" *pinnatiformis* (Blv.).	Volta, Pl. 4; Ag., IV. Pl. 41.
76.	" *subvespertilio* (Blv.).	Volta, Pl. 6.
77.	" " "	Ag., IV. Pl. 41 *a*.
78.	*Platinx intermedius* Eastm.	*(In press.)*
79.	" *macropterus* (Blv.).	Ag., V. Pl. 14.
80.	*Platyrhina gigantea* (Blv.).	Volta, Pl. 61.
81.	*Pomacanthus subarcuatus* (Blv.).	Volta, Pl. 8, Fig. 1; Ag., IV. Pl. 19, Fig. 2.
82.	*Pristigenys substriatus* (Blv.).	Volta, Pl. 20, Fig. 2.
83.	*Pristipoma furcatum* (Ag.).	Ag., IV. Pl. 39, Fig. 1.
84.	*Pseudosyngnathus opisthopterus* (Ag.).	Volta, Pl. 58, Fig. 1.

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[1] The relations of this type are discussed by Cuvier in Mém. Mus. d'Hist. Nat., Vol. I. (1815), p. 321.

85.	*Pterygocephalus paradoxus* Ag.	Ag., IV. Pl. 32, Figs. 5, 6.
86.	*Pycnodus apodus* (Volta).	Volta, Pl. 35, Fig. 1.
87.	*Pygaeus bolcanus* (Volta).	Volta, Pl. 59; Ag., IV. Pl. 20.
88.	*Rhamphosus rastrum* (Volta).	Volta, Pl. 5, Fig. 4; Ag., IV. Pl. 32, Fig. 7.
89.	“ “ “	Volta, Pl. 75, Fig. 1.
90.	*Rhamphognathus paralepoides* Ag.	Ag., V. Pl. 38, Fig. 1.
91.	“ *sphyraenoides* (Ag.).	Volta, Pl. 24, Fig. 3; Ag., V. Pl. 38, Fig. 2.
92.	*Scatiphagus frontalis* Ag.	Ag., IV. Pl. 39, Fig. 4.
93.	*Semiophorus velicans* (Blv.).	Volta, Pl. 7, Fig. 3; Ag., IV. Pl. 37.
94.	“ *velifer* (Volta).	Volta, Pl. 7, Fig. 1; Ag., IV. Pl. 37 *a*, Fig. 2.
95.	“ “ “	Volta, Pl. 7, Fig. 2; Ag., IV. Pl. 37 *a*, Fig. 1.
96.	*Seriola analis* (Ag.).	Volta, Pl. 69, Fig. 1.
97.	“ *prisca* (Ag.).	Ag., V. Pl. 11 *a*.
98.	*Serranus rugosus* Heckel.	Ag., IV. Pl. 23 *b* (*supra*).
99.	*Sparnodus elongatus* Ag.	Volta, Pl. 32, Fig. 1; Ag., IV. Pl. 23 *b* (*infra*).
100.	“ “ “	Volta, Pl. 31, Fig. 1; Ag., IV. Pl. 28, Fig. 1.
101.	“ *microstomus* (Ag.).	Volta, Pl. 45, Fig. 3.
102.	“ “ “	Ag., IV. Pl. 23, Figs. 1, 2.
103.	*Sparnodus vulgaris* (Blv.).	Volta, Pl. 13, Fig. 1, and Pl. 17, Fig. 1; Ag., IV. Pl. 29, Fig. 2.
104.	“ “ “	Volta, Pl. 60, Fig. 2; Ag., IV. Pl. 28, Fig. 3.
105.	“ “ “	Volta, Pl. 73.
106.	“ “ “	Ag., IV. Pl. 29, Fig. 1.
107.	“ “ “	Ag., IV. Pl. 29, Fig. 3.
108.	*Sphyraena bolcensis* Ag.	Volta, Pl. 62.
109.	*Spinacanthus cuneiformis* (Blv.).	Volta, Pl. 13, Fig. 2; Ag., V. Pl. 39, Fig. 1.
110.	*Thynnus* (?) *bolcensis* Ag.	Volta, Pl. 27.
111.	“ *lanceolatus* (Ag.).	Volta, Pl. 29, Fig. 1.
112.	“ “ “	Ag., V. Pl. 23.
113.	“ (?) *propterygius* Ag.	Ag., V. Pl. 27.
114.	*Toxotes antiquus* Ag.	Volta, Pl. 45, Fig. 1; Ag., IV. Pl. 43.
115.	*Trachynotus tenuiceps* Ag.	Volta, Pl. 39, Fig. 3; Ag., V. Pl. 7, Figs. 1, 2.
116.	*Trygon muricatus* (Volta).	Volta, Pl. 9, Fig. 1.
117.	“ “ “	Volta, Pl. 9, Fig. 2.
118.	*Urolophus crassicaudatus* (Blv.).	Type not figured (*de est ?*).
119.	*Urosphen dubia* (Blv.).	Volta, Pl. 29, Fig. 4.

120.	*Urosphen dubia* (Blv.).	Ag., IV. Pl. 35, Fig. 6.
121.	*Vomeropsis triurus* (Volta).	Volta, Pl. 44, Fig. 2; Ag., V. Pl. 6.
122.	" " "	Volta, Pl. 35, Fig. 3; Ag., V. Pl. 5.
123.	*Xiphopterus falcatus* (Volta).	Volta, Pl. 57.
124.	*Zanclus brevirostris* Ag.	Volta, Pl. 26, Fig. 2; Ag., IV. Pl. 38, Figs. 1, 2.

II. SYSTEMATIC DESCRIPTIONS.

ELASMOBRANCHII.

RAJIDAE.

Platyrhina gigantea (Blv.).

1796. *Raja torpedo* G. S. Volta, Ittiolit. Veronese, p. 521, Plate LXI.
1818. *Narcobatus giganteus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., xxvii. p. 337.
1835. *Torpedo gigantea* L. Agassiz, Neues Jahrb., p. 297 (name only).
1843. *Torpedo gigantea* L. Agassiz, Poiss. Foss., iii. p. 382; ** iv. p. 38 (name only).
1860. *Narcine gigantea* R. Molin, Sitzungsber. Akad. Wiss. Wien, xl. p. 585.
1874. *Torpedo gigantea* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 177.
1894. *Platyrhina gigantea* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 108, text-fig. 19.

The holotype of this species is preserved in the Paris Museum of Natural History, and not, as stated by Baron de Zigno, in the second Gazola Collection at Verona. In its present state the disk is remarkable for its great antero-posterior elongation. De Blainville was of the opinion that this was not a character properly belonging to the specimen, but one due to deceptive appearances, a portion of the disk having become folded upon itself. O. Jaekel, without having had access to the specimen, imagined that the disk had become deformed by mechanical agencies subsequent to the death of the creature. An examination of the original leads the present writer to conclude that there is no evidence of a folding over of the edges of the disk, nor of distortion due to pressure or other causes. Although extremely probable that the lateral margin of the disk escaped fossilization, it nevertheless appears certain that the form was more elongated longitudinally than in the majority of rays.

TRYGONIDAE.

Trygon muricatus (Volta).

1796. *Raja muricata* G. S. Volta, Ittiolit. Veronese, p. 37, Plate IX. Figs. 1, 2.
1818. *Trygonobatus vulgaris* H. D. de Blainville, Nouv. Dict. d'Hist. Nat. xxvii. p. 336.

1835. *Trygon gazzolae* L. Agassiz, Neues Jahrb., p. 297 (name only).
1839. *Trygon gazzolae* L. Agassiz, Poiss. Foss., iii. p. 382 **; vol. iv. p. 38 (name only).
1851. *Trygon gazzolae* J. Heckel, Sitzungsber. Akad. Wiss. Wien, vii. p. 325.
1861. *Alexandrinum*, sp. R. Molin, Sitzungsber. Akad. Wiss. Wien, xlii. p. 579.
1874. *Alexandrinum molini* A. de Zigno, Mem. R. Istit. Veneto, xviii. p. 299, Pl. XII.
1874. *Trygon gazolae* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 180.
1894. *Trygon* (*Taeniura*) *muricatus* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 142, Plate IV. text-fig. 32.

One can gain some idea of the difficulties attending the identification and designation of this species from the following statements of Dr. Jaekel:

> "Es ist auffallend, dass eine Form, die bereits von Volta vortrefflich beschrieben und abgebildet war, und welche durch ihren reich gegliederten Skeletbau so leicht kenntlich ist, so viele nachträgliche Benennungen erfahren hat. Volta kannte und beschrieb das hier Tafel IV abgebildete Exemplar der Collection Gazola; allerdings rechnete er zu der gleichen Art, die er als *Raja muricata* bezeichnete, noch ein mit einem Stachel besetztes Schwanzfragment (*l. c.* Taf. ix. Fig. 2), welches zu *Urolophus crassicauda* [*sic*] gehort. . . . Zu den späteren Benennungen gab z. Th. die Auffindung neuer Exemplare und die Nichtberücksichtigung des vorher beschriebenen Veranlassung. So enstanden auf Grund eines Exemplares in den Pariser Sammlung die Namen *Trygonobatus vulgaris* de Blainville und *Trygon Gazzolae* Agassiz, von welchen die letztere, obwohl er ohne Beschreibung veröffentlicht wurde, sich in der Litteratur am meisten einbürgerte. Dass Molin lediglich auf Grund der distalen Stellung des Schwanzstachels eine neue Gattung *Alexandrinum* aufstellte, . . . kann nicht gerechtfertigt erscheinen" (p. 142).

The above extract is in complete accord with the views of the present writer, save in one particular, which concerns the presence in this species of the form of caudal spine attributed to it by Volta. Heckel, and following him most writers, have maintained that the original of Volta's Pl. IX. Fig. 2 does not belong to *Trygon muricatus*, but to another form of ray altogether, that now known under the name of *Urolophus crassicaudatus* (Blv.). It is probable, however, that the same form of dermal defence is common to both species. As for the original of Volta's figure, either the identical specimen, or one so closely resembling it as to be indistinguishable from it, is preserved in the Paris Museum of Natural History; and this is seen very clearly to belong to a complete individual of *Trygon muricatus*.

Urolophus crassicaudatus (Blv.).

1818. *Trygonobatus crassicaudatus* H. d. de Blainville, Nouv. Dict. d'Hist. Nat. xxvii. p. 337.
1835. *Trygon oblongus* L. Agassiz, Neues Jahrb., p. 297.
Trygon oblongus L. Agassiz, Poiss. Foss., iii. p. 382, **, iv. p. 38.
1851. *Trygon brevicauda* J. Heckel, Sitzungsber. Akad. Wiss. Wien, vii. p. 324.
1853. *Urolophus princeps* J. Heckel, Sitzungsber. Akad. Wissen. Wien, xi. p. 122.

1861. *Taeniura kneri* R. Molin, Sitzungsber. Akad. Wiss. Wien, xlii. p. 581.
1863. *Urolophus princeps* Kner und Steindachner, Denkschr. Akad. Wiss. Wien, xxi. p. 82, Plate VI. Fig. 2.
1874. *Trygon oblongus* A. de Zigno, Catalogo Ragionato dei Pesci Fossili, p. 181.
1874. *Taeniura kneri* A. de Zigno, *ibid.*, p. 182.
1874. *Urolophus princeps* A. de Zigno, *ibid.*, p. 183.
1889. *Taeniura kneri* A. S. Woodward, Cat. Fossil Fishes Brit. Mus., pt. i. p. 153.
1894. *Urolophus crassicauda* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 148, Plate V.

It seems desirable to give the complete synonymy of this species, as there is no possible reason for doubting that all of the rays described under the various names cited above belong to a single species. There is no specimen at the Paris Museum which can be certainly identified as the type either of de Blainville's *Trygonobatus crassicaudatus*, or of Agassiz's *Trygon oblongus*.

CARCHARIIDAE.

Carcharias (Scoliodon) cuvieri (Agassiz).

(Text-figure *A*.)

1796. *Squalus carcharias* G. S. Volta, Ittiolit. Veronese, p. 10, Plate III. Fig. 1.
1807. *Squalus vulpes* Scortegagna, F. O., Memoria epistolare al Sig. Faujas-St.-Fond.
1807. *Squalus carcharias* G. Gazola, Lettera al Sig. Scortegagna, &c.
1818. *Squalus innominatus* (*errore*) H. D. de Blainville, Nouv. Dict. d'Hist. Nat. xxviii. p. 386.
1835. *Galeus cuvieri* L. Agassiz, Neues Jahrb., p. 291.
1839. *Galeus cuvieri* L. Agassiz, Poiss. Foss., iv. p. 88.
1860. *Protogaleus minor* (*pars*) R. Molin, Sitzungsber. Akad. Wiss. Wien, xl. p. 583.
1874. *Alopiopsis cuvieri* (*pars*) A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 174.
1894. *Galeus cuvieri* O. Jaekel, Die eocänen Selachier vom Monte Bolca, p. 172, text-fig. 38.

The holotype of this species forms part of the Gazola Collection in Paris, and another specimen slightly smaller than the type is preserved in the University of Padua Museum. An outline figure of the latter is given by Jaekel, and likewise the following description: —

> "Was nun schliesslich das kleinere, vorstehend abgebildete Exemplar der Paduaner Sammlung betrifft, so ist dasselbe fast vollständig erhalten, also wesentlich besser, als das von Volta abgebildete und von Agassiz als *Galeus cuvieri* bezeichnete. . . . Die Brustflossen sind schlank, fast sichelformig rückwarts gekrümmt."

Regarding the type-specimen in the Paris Museum the same author remarks that the rostral region is incompletely preserved, and "von den Flossen sind nur die beiden Brustflossen deutlich." A little further on, however, he says: "Die erste Rückenflosse ist auch bei dem Pariser Exemplar an derselben Stelle angedeutet, wo sie bei dem hier abgebildeten sitzt, nämlich unmittelbar über dem Hinterrand der Brustflossen. Auch die zweite Dorsalis und die Analis scheinen bei dem Pariser Stück an der gleichen Körperstelle, wie an dem Paduaner, übereinander zu stehen. . . . Ueber die Form der Schuppen und sonstigen Einzelheiten konnte ich leider an dem Pariser Stück keine zuverlässige Beobachtung anstellen" (p. 174).

The present writer has not been able to verify the above description in all particulars, but on the other hand has found it possible to observe some details not previously made known.

The specimen, by the way, is preserved on a single slab, and the catalogue of the Museum does not show that it ever existed in counterpart, although the contrary is affirmed by Jaekel. The anterior third of the trunk lies squarely on its back in the matrix, the first dorsal fin being thus wholly or for the most part concealed. The remainder of the trunk is visible from the lateral aspect, and the fins which it exhibits are the posterior dorsal, anal, and a portion of the lower lobe of the caudal, as indicated in the accompanying Figure *A*. A small triangular mass of scales lying immediately in front of the posterior dorsal may perhaps be interpreted as a ruptured portion of the shagreen, or possibly even as the displaced tip of the anterior dorsal.

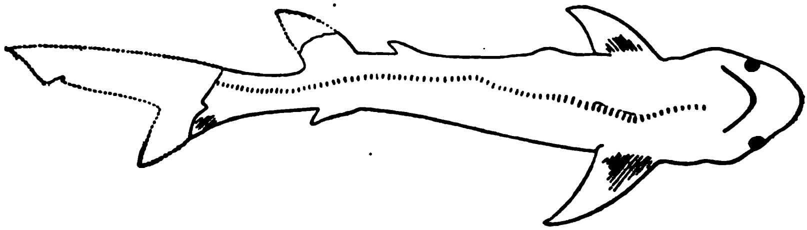

FIG. *A*. Type-specimen of *Carcharias* (*Scoliodon*) *cuvieri* (Ag.). × $\frac{1}{10}$. Extremities of the dorsal and caudal fins hypothetically restored.

The shagreen is very excellently preserved over various portions of the body, the form and structure of the individual scales appearing as distinct as in life. The shagreen granules agree so perfectly with those of the recent Scoliodon that no further description is necessary, and the same is true of the dentition. A number of the teeth are preserved in their natural position in the mouth region, and all exhibit very clearly the inclined triangular crown with smooth edges characteristic of Scoliodon. It will be seen that the identification which is here made of this shark as a species of Scoliodon is in accordance with all the characters, except that the rostrum appears to have been rather less prolonged. In the above text-figure, the posterior dorsal and caudal fins have been hypothetically restored.

Altogether seventeen species of elasmobranchs are known from the Monte Bolca horizon, a list of which is subjoined:

SPECIES OF ELASMOBRANCHS FROM MONTE BOLCA.

1. *Rhinobatis zignii* (Heckel).
2. " *primaevus* Zigno.
3. *Platyrhina bolcensis* (Heckel).
4. " *egertoni* Zigno.
5. " *gigantea* (Blv.).
6. *Narcine molini* Jaekel.
7. *Trygon muricatus* (Volta).
8. " *zignii* (Molin).
9. *Urolophus crassicaudatus* (Blv.).
10. *Promyliobatis gazolae* (Zigno).
11. *Lamna vincenti* Winkler.
12. *Odontaspis hopei* Ag.
13. *Carcharodon auriculatus* (Blv.).
14. *Pseudogaleus voltai* Jaekel.
15. *Alopiopsis plejodon* Lioy.
16. *Carcharias* (*Scoliodon*) *cuvieri* (Ag.).
17. *Mesiteia emiliae* Kramb.

TELEOSTOMI.

ACTINOPTERYGII.

ALBULIDAE.

MONOPTERUS VOLTA.

Trunk elongated oval and laterally compressed. Head relatively short, with steep frontal profile; opercular bones well developed. Vertebrae at least 60 in number, half of them being caudal. Length of anterior pectoral fin-ray exceeding maximum depth of trunk; pelvic fins minute, situated nearer the anal than the pectoral pair. Anal placed opposite the dorsal, and rising into an acuminate lobe in front. Caudal very deeply forked, with a scaly lamella extending over the middle of the tail at the base. Mouth opening small, a series of conical teeth present along the margin of the jaws, and a series of hemispherical crushing teeth placed further back.

Monopterus gigas VOLTA.

1796. *Monopteros gigas* G. S. Volta, Ittiolit. Veronese, p. 191, Plate XLVII.
1818. *Monopteros gigas* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., xxvii. p. 357.
1835. *Platinx gigas* L. Agassiz, Neues Jahrb., p. 304.
1838–44. *Platinx gigas* L. Agassiz, Poiss. Foss., v. pt. 2, p. 126.
1874. *Platinx gigas* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 151.

The removal of this species from the genus Platinx, and its transfer to the vicinity of Chanos, amongst the Albulidae, appears warranted by the presence of numerous hemispherical crushing teeth in the pharyngeal region, and by the structure of the caudal and other fins. The dorsal and anal are situated opposite each other, and consist each of 20 rays. The caudal is short and much expanded, covered with a scaly lamella along the middle at its base, and the distance between the extremities of its lobes exceeds the maximum depth of the trunk. All of the fins have the foremost ray covered with a finely rugose dermal layer, and the anterior pectoral fin-ray is as much enlarged and elongated as in certain Osteoglossidae and Chirocentridae. This species, of which several examples are known, attains a total length of about 80 cm.

SCOPELIDAE.

Holosteus esocinus Agassiz.

1838–44. *Holosteus esocinus* L. Agassiz, Poiss. Foss., v. pt. 2, p. 85, Plate XLIII. Fig. 5.

1856. *Holosteus esocinus* H. G. Bronn, Lethaea Geognostica, p. 683, Plate XLII.[3] Fig. 8.

1874. *Holosteus esocinus* A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 140.

The holotype and only known example of this species is an imperfectly preserved fish belonging to the Gazola Collection of the Paris Museum. It bears on the reverse the following MS. inscription in Agassiz's handwriting: "Cette plaque est évidemment composée de pièces incoherentes, surtout de la partie antérieure de la dorsale, et vers le front de la tête; cependant la colonne vertebrale indique un poisson d'un genre nouveau voisin de *Belone.*"

An examination of the specimen shows that the vertebral column is intact from the occiput at least as far as the insertion of the dorsal fin, the latter being unquestionably preserved in its natural position. It is evident that the triangular piece intended to represent the interneurals supporting the dorsal does not belong to this fish, and the same remark applies also to another fragment introduced in advance of the dorsal, which was properly recognized by Agassiz as "n'étant q'une fausse dorsale." Although the authenticity of the anal itself is doubtful, its position is shown by the presence of fin-supports to be opposite the dorsal. Very little of the portion posterior to the anal fin can be regarded as other than a factitious mosaic.

CARANGIDAE.

Caranx primaevus, sp. nov.

(Plate 1, Fig. 4; Text-fig. *B*.)

A small species attaining a total length of about 10 cm. Head with opercular apparatus contained slightly less than 3½ times in the total length to base of caudal fin. Trunk laterally compressed, elongated, regularly fusiform. Anterior dorsal fin with about 8 spines of moderate length, closely followed by the low second dorsal with about 20 soft rays. Anal fin opposed to the posterior dorsal, and apparently of equal extent, preceded by two short and separate anal spines. Dorsal and anal finlets not observed. Scales thin and small. Lateral line with well-developed scutes along its entire length, the line arching upward and the scutes becoming shorter anteriorly; number of scutes about 65.

The unique individual upon which the above description is based exists in counterpart, and details taken from both halves have been combined in the adjoining Figure *B*. This is the earliest recorded appearance of the genus in geological history, the half-dozen fossil species that are known being confined to the Oligocene and Miocene. Amongst the latter *C. ovalis*, which is imperfectly known, seems to have resembled the present species in general outline, and amongst modern forms the species commonly referred to "*Trachurus*" (e.g., *Caranx trachurus* and *C. picturatus*) present the same peculiarity of having scutes developed along the entire length of the lateral line.

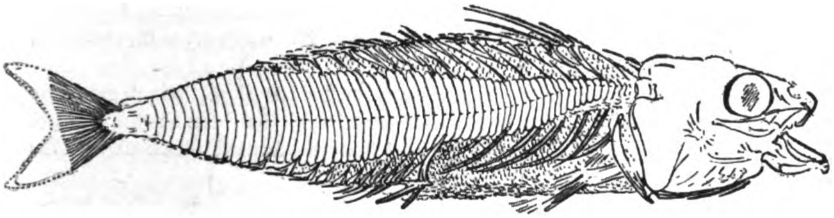

FIG. *B*. *Caranx primaevus*, sp. nov. × $\frac{1}{1}$.

The type-specimen, which is from Monte Bolca, is preserved in the Museum of Comparative Zoölogy.

LABRIDAE.

Symphodus szajnochae (ZIGNO).

(Plate 1, Fig. 5.)

1887. *Crenilabrus szajnochae* A. de Zigno, Mem. R. Istit. Veneto, xxiii. p. 17, Fig. 8.

Besides the holotype of this species, which is small and imperfectly preserved, no other examples have come to light until recently, when one was acquired for the Museum of Comparative Zoölogy, and another for the Carnegie Museum at Pittsburgh. The individual belonging to the Cambridge collection is preserved in counterpart, and is interesting for the additional information which it affords in regard to certain structural details.

This example has a total length of 10 cm. to the base of the caudal fin, and in this distance the head with opercular apparatus is contained four times.

The preoperculum is strongly serrated, its posterior border being produced into very prominent spines. The marginal teeth are conical and arranged in single series, no pharyngeal teeth being observed. The vertebrae are about 25 in number, of which 14 are caudal. The dorsal fin is much extended, with about 26 rays, and of these 11 are spinous. The caudal is composed of 17 principal rays, there being one more in the upper than in the lower lobe, and these are preceded both above and below by four or five spinelets. The anal appears to be formed of about eight rays in addition to the spines, but their number cannot be accurately counted. There are at least eight branchiostegal rays. Evidence of the former extension of the scales over the opercular bones and cheeks is not apparent in the present condition of the specimen, nor in fact is it ordinarily to be expected amongst fossils. The scales are thin, ctenoidal, and very strongly pectinated.

Crenilabrus was separated by Cuvier from Labrus as a distinct genus on account of its having a serrated preoperculum, but it has been shown by D. S. Jordan in his Review of Labroid Fishes[1] that the form is identical with the earlier described Symphodus of Rafinesque.

CHAETODONTIDAE.

PYGAEUS Agassiz.

To this imperfectly known extinct genus have been referred half a dozen species from the Bolca Eocene, and two from the Lower Miocene of Chiavon, Vicentin. The type species is *P. bolcanus* (Volta), renamed *P. gigas* by Agassiz. This is a large form, attaining a total length of about 35 cm., the remaining species being very much smaller, and included by Agassiz only provisionally in the same genus with the type. It appeared to Agassiz that the smaller forms constituted a group by themselves, typified by *P. coleanus*, but passing over into the group of larger forms through the intermediate *P. oblongus*. Concerning the advisability of subdividing the genus, Agassiz remarks as follows: "Il faudra donc probablement démembrer un jour ces espèces et en faire autant des genres qu'on y reconnaîtra de types differents, en les étudiant d'une manière plus complète; ce qui sera d'autant plus difficile que les Pygées sont fort rares dans les collections."

There are in addition to the small number of forms known to Agassiz two other species represented by a solitary individual each, which are evidently closely akin to *Pygaeus bolcanus*, although possessing more finely divided vertical fins. These are the so-called *Acanthurus gazolae* Massalongo[2] and *A. gaudryi* de Zigno,[3] from the Bolca Eocene, whose true position amongst

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[1] Jordan, D. S., A Review of the Labroid Fishes of America and Europe, Rept. U. S. Fish Comm. for 1887, pp. 559–699, 1891.

[2] Specimen Photogr. Anim. Foss. Agr. Veron., 1859, p. 26.

[3] Atti R. Istit. Veneto, xxiii. 1887, p. 14, Fig. 2.

Chaetodonts has already been suspected by Smith Woodward. It is probable that they represent types of distinct genera, but for the present they may be most conveniently included within the limits of Pygaeus, as purposely extended by Agassiz. It is evident that some of these forms are closely related to modern Acanthuridae, the chief differences consisting in the great development of the dorsal spines, and the fact that the maxilla and premaxilla are distinct. The latter condition is alone sufficient to warrant the retention of these larger species of Pygaeus amongst the Chaetodontidae, rather than amongst the Acanthuridae, or so-called "Acronuridae" of Günther, and Teuthidae of Jordan. On the other hand, the teeth are much stouter than in living Chaetodonts.

We have now to offer the description of a new species of Pygaeus, as construed in its broader sense, no division of this genus being at present attempted.[1] The type-specimen formerly belonged to the Marchese di Canossa Collection, a part of which was purchased some months ago for the Museum of Comparative Zoölogy. The choice of a specific title has been determined by the desire to commemorate the labors of the master in this field, his name not being similarly associated with any other member of the Bolca fauna.

Pygaeus agassizii, sp. nov.

(Plate 2.)

D. 10 + 9; A. 5 + 8; V. 5; P. 17 or 18.

A comparatively large species, attaining a total length of about 19 cm. Maximum depth of trunk contained twice, and length of head with opercular apparatus three times in the total length to base of caudal fin. Dorsal fin arising immediately behind the occiput and extending as far as the caudal pedicle with ten subequal spines and nine articulated rays, the latter not longer than the former, and not produced into an acute lobe in front. Anal spines gradually increasing in length and stoutness from the first onward, the fifth equalling the foremost articulated ray in length, and longitudinally striated. Articulated portion of the anal corresponding in size and position to the articulated dorsal. Abdominal vertebrae 10, caudal 13. Large incisiform teeth present in front, gradually diminishing in size posteriorly, apparently in single series; maxilla and premaxilla clearly separate. Scales small, those of the posterior part of the body in the form of shagreen-like calcifications and tubercles. Neural spines of abdominal region and all of the interspinous bones much expanded; pelvic bones strongly developed. No lateral caudal spines.

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[1] The writer is indebted to President Jordan, than whom is no higher authority, for the suggestion that "*Pygaeus*, and possibly *Apostasis* also, should be taken as representing a distinct family, which would occupy a more central position near the common ancestry of *Acanthuridae Chaetodontidae*, and *Siganus* (*Teuthis*)" (*litt.*, May, 1904).

The general outline of body in this species is more suggestive of Acanthurus than Pygaeus, but the fin-structure is wholly in accord with the latter genus. The development of the spinous dorsal is about equal to that of the type species of Pygaeus, but the articulated dorsal is less strongly developed. This is a character of specific importance, and its variation amongst different forms belonging to the same general group is indicated by the following formulae:

Pygaeus bolcanus	D. 10 or 12 + 20 (*fide* Agassiz).
" *agassizii*	D. 10 + 9; A. 5 + 8.
" *nobilis*	D. 12 + 12; A. 8 + 12.
" *coleanus*	D. 14 + 15; A. 9 + 11.
Acanthurus gaudryi	D. 7 + 28; A. 3 + 25.
" *tenuis*	D. 9 + 21; A. 3 + 19.

LOPHIIDAE.

Histionotophorus, nomen nov.

[*Histiocephalus* A. de Zigno, 1887.]

The name proposed for this genus by Baron de Zigno is not only inappropriate but preoccupied, Diesing having applied it to a genus of Vermes in 1851. The title Histiocephalus may therefore be discarded in favor of *Histionotophorus*, which is bestowed in allusion to the sail-like median fin extending along the back.

Histionotophorus bassani (Zigno).

(Plate 1, Figs. 1-3; Text-fig. *C*.)

1887. *Histiocephalus bassani* A. de Zigno, Mem. R. Istit. Veneto, xxiii. p. 81, Fig. 9.

D. I – I – I + 13; C. 8; A. 9; V. 7; P. 6.

A comparatively small pediculate species attaining a total length to the base of the caudal fin of about 6 cm. Mouth oblique, maxillary extending far downward, dentary thickened, jaws with cardiform teeth, skin naked. Anterior dorsal of three separated tentacle-like spines on the head, posterior dorsal high, much extended, with thirteen articulated rays, the fin-membrane stiffened at the base with small spiniform calcifications. Pectoral members situated immediately above the origin of the anal fin, their short rays directed vertically, and supported by extremely long pseudobrachia, which are apparently composed of two actinosts. Number of vertebrae apparently not more than 18 (according to de Zigno, however, there are 22 in the type, 10 abdominal and 12 caudal).

Three specimens answering to the above description, two of them in counterpart, are preserved in the Museum of Comparative Zoölogy, and their principal characters are combined in the accompanying text-figure, so far as they are observable. There is little room for doubt that these interesting and rare pediculates are identical with the species described by Baron de Zigno under the name of *Histiocephalus bassani*, although the type-specimen is so imperfectly preserved that his description is at variance in some points with the one given above, and the affinities of the type have remained more or less obscure. The latter, indeed, was referred to the Scorpaenidae by Dr. A. S. Woodward in his Catalogue of Fossil Fishes in the British Museum. The characteristic pectoral members are not shown in de Zigno's illustration of this form, and the head is much disfigured; as for a supposed membrane supported by the cephalic spines (to which the name Histiocephalus alludes), no indication is afforded by the new material that such a structure existed. An interesting fact to be noted is the close correspondence existing between the fin-formulae of the fossil and recent species. In the common Angler, *Lophius* *piscatorius*, for instance, as well as in the form under discussion, the first and second dorsal together comprise 13 rays, and the number of rays belonging to the caudal, anal, and ventral fins is identical in both species.

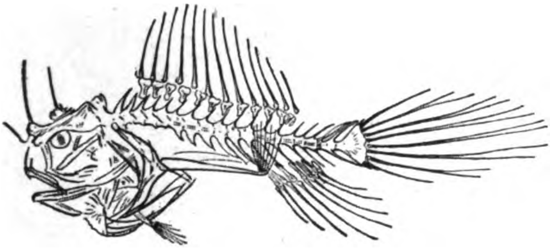


FIG. C. *Histionotophorus bassani* (de Zigno). × $\frac{1}{1}$. A composite drawing based upon three individuals belonging to the Mus. Comp. Zoöl.

It is to be regretted that the cranial osteology is not more clearly displayed, as it would be interesting to compare the various degrees of modification exhibited by the Eocene and modern pediculates. The recent genus Corynolophus exhibits a similar thickening of the dentary and other bones of the lower jaw, and another resemblance is seen in the construction of the premaxillaries, which are probably movable, but further than this we cannot go. Attention should be called, however, to the remarkable fact of a type of fish-life appearing suddenly in the Eocene, already highly modified, without any known predecessors nor any that can be plausibly conjectured, but which persists after its first introduction essentially unchanged until modern times.

GYMNODONTIDAE.

Diodon erinaceus Agassiz.

(Text-figure *D*.)

1844. ***Diodon erinaceus*** **L. Agassiz, Poiss. Foss., ii. pt. ii. p. 274.**
1859. ***Diodon erinaceus*** **A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 21, Plate XII. Fig. 2.**
1874. ***Diodon erinaceus*** **A. de Zigno, Catalogo ragionato dei Pesci Fossili, p. 163.**
1876. ***Diodon erinaceus*** **F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., iii. p. 180.**
1901. ***Diodon erinaceus*** **A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. iv. p. 572.**

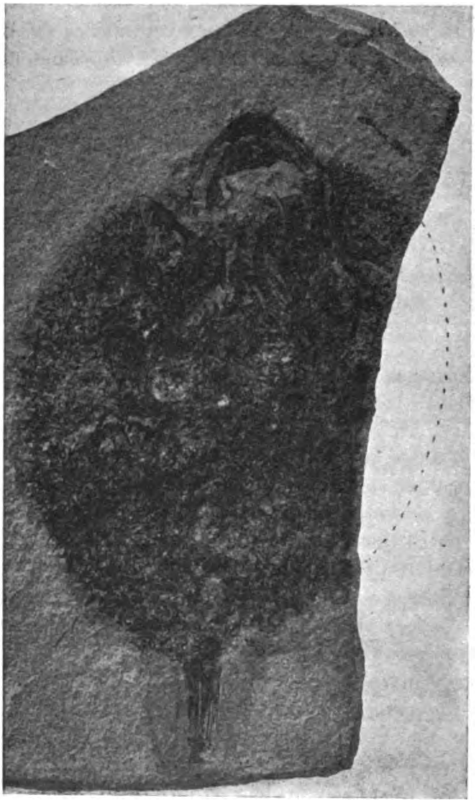


Fig. *D*. *Diodon erinaceus* Ag. × ½.

This species has never been satisfactorily defined, and with the extremely limited material that has thus far been obtained, a precise definition is not yet

possible. Agassiz's sole description consists in the statement that it is "une espèce de trois pouces de long, remarquable par sa forme ovale et par ses piquants courts, robustes et assez clair-semés." Of the type-specimen, now preserved in the British Museum, Dr. Woodward states that it is exposed from the ventral aspect, has the dentition much obscured, and "no fins are seen except part of the caudal. The largest and most slender spines are at the sides of the middle of the trunk."

The type-specimen has never been figured, and the species is so little known that it seems desirable to furnish an illustration of a specimen closely resembling the type, which has recently been secured by the Museum of Comparative Zoölogy. This is shown from the ventral aspect in the adjoining text-figure 4, and it will be seen that scarcely any differences are to be noted between it and the so-called "*Enneodon echinus*" of Heckel. In the latter, according to this author, "der Oberkiefer ist mit sieben kleinen Zahnplatten besetzt, die gleich einer Reihe flacher Schneidezähne dicht an einander stehen." There are some obscure indications that separate teeth were also present around the margin of the upper jaw in *Diodon erinaceus*, but as this cannot be absolutely demonstrated at present, it is not deemed advisable to unite these two species. The lower dental plate is well shown from the inferior aspect in the Cambridge specimen, and does not appear to have been divided by a median longitudinal suture. Pelvic fins are not observable, nor has the writer been able to detect them in any specimen of *D. tenuispinus* from Monte Bolca thus far examined by him. An example of this species so closely resembling the type as to have been confused with it by some writers is treasured amongst the splendid collection belonging to the Paris Museum of Natural History. For the exceptional favors and facilities enjoyed at the hands of M. Albert Gaudry and M. Boule during his study of this collection the past year, the writer finds it difficult to express his deep sense of obligation and gratitude.

EXPLANATION OF PLATES.

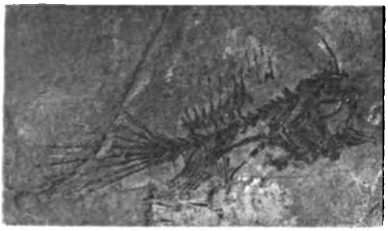
All figures are of the natural size, and the originals are preserved in the Museum of Comparative Zoölogy.

PLATE 1.

Figs. 1–3. *Histionotophorus bassani* (Zigno). Upper Eocene; Monte Bolca. Figs. 1 and 1 *a* are counterparts of the same specimen.
Fig. 4. *Caranx primaevus*, sp. nov. Upper Eocene; Monte Bolca.
Fig. 5. *Symphodus szajnochae* (Zigno). Upper Eocene; Monte Bolca.

PLATE 2.

Pygaeus agassizii, sp. nov. Upper Eocene; Monte Bolca (*ex* Canossa Collection).



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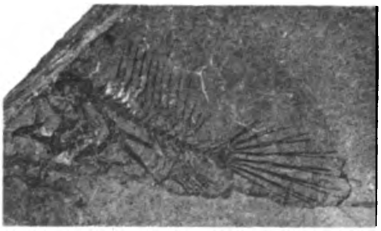

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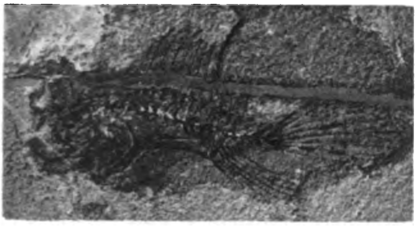

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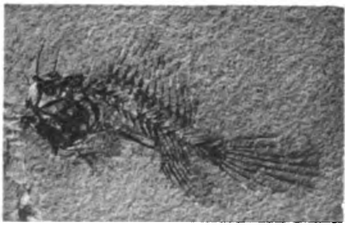

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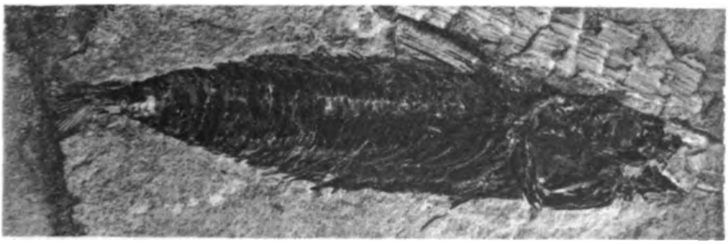

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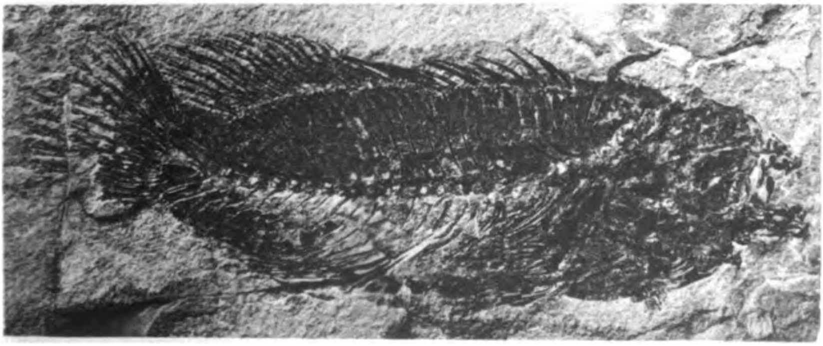

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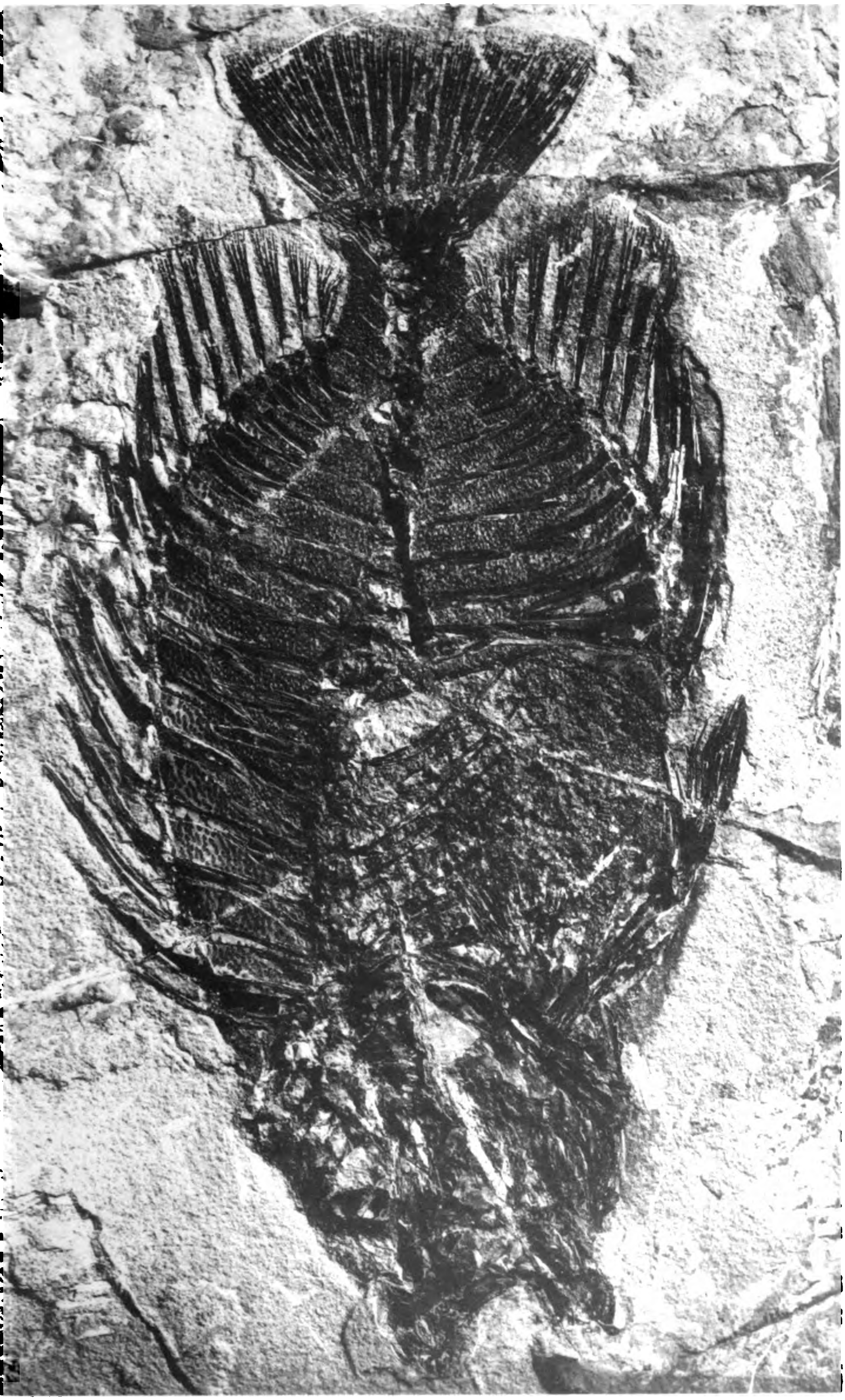

The following *Publications* of the Museum of Comparative Z
are in preparation:—

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge
ANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in c
ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from
1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

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E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
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A. AGASSIZ and A. G. MAYER. The Acalephs of the East Coast of the United St
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

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S. J. HICKSON. The Antipathids.
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C. A. KOFOID. Solenogaster.
R. VON LENDENFELD. The Phosphorescent Organs of Fishes.
H. LUDWIG. The Starfishes.
J. P. McMURRICH. The Actinarian
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Spec
P. SCHIEMENZ. The Pteropods an
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M. P. A. TRAUSTEDT. The Salpi
Doliolidæ.
H. B. WARD. The Sipunculids.
H. V. WILSON. The Sponges.
W. McM. WOODWORTH. The Nem
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PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the Bulletin Vols. I. to XLI., and also Vol. XLIV.; of the Memoirs, Vols. I. to XXIV., and also Vols. XXVIII. and XXIX.

Vols. XLII., XLIII., XLV., XLVI., and XLVII. of the Bulletin, and Vols. XXV., XXVI., XXVII., XXX., and XXXI. of the Memoirs, are now in course of publication.

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Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

1904

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE
Vol. XLVI. No. 2.

MALDIVE CEPHALOCHORDATES,

WITH THE DESCRIPTION OF A NEW SPECIES FROM FLORIDA.

By G. H. Parker.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
Sm November, 1904.

No. 4. — *Three Letters from* ALEXANDER AGASSIZ *to the* HON. GEORGE M. BOWERS, *United States Fish Commissioner, on the Cruise, in the Eastern Pacific, of the U. S. Fish Commission Steamer "Albatross,"* LIEUT. COMMANDER L. M. GARRETT, U. S. N., *Commanding.*

I.

LIMA, PERU, November 28, 1904.

THE "Albatross," under command of Lieutenant-Commander L. M. Garrett, left San Francisco on the 6th of October and arrived at Panama the 22d. On her way along the coast Professor C. A. Kofoid took advantage of the opportunity for making surface hauls with the tow nets as well as vertical hauls, generally to a depth of 300 fathoms. A large amount of pelagic material was thus collected, not at a great distance from the coast however. Off Mariato Point the "Albatross" made two hauls in the vicinity of the stations where in 1891 she found "modern green sand," in about 500 and 700 fathoms. It was interesting to find the green sand again, as the specimens collected in 1891 were lost in transit to Washington. I am fortunate in having as assistant for this trip, Professor Kofoid, who has had great experience in studying the Protozoa both in fresh water and at sea. He has been given charge of the collection of Radiolarians and Diatoms and of other minute pelagic organisms; and he will prepare a report on the results of that branch of the work of the expedition.

The "Albatross" arrived at Panama on the 22d; she was coaled and provisioned at once. On my arrival at Panama on the 1st of November I found her ready for sea, and on the 2d we left for Mariato Point to make a few additional trawl hauls in the region of the green sand. In both the hauls made off Mariato Point green sand was found, but not in the quantity obtained in 1891.

From Mariato Point we made a straight line of soundings towards Chatham Island in the Galapagos, intersecting the ring of soundings we made northeast of the islands in 1891. The deepest point of the line (1900 fathoms) was found about 100 miles southwest of Mariato

Point. The bottom continued to show about 1700 fathoms for nearly 200 miles, and then shoaled very gradually to 1418 fathoms about 80 miles from Chatham Island. The slope became quite steep, the 1000-fathom line not being more than 60 miles from Chatham Island. We ran a short line south of Hood Island, and found a somewhat steeper slope to that face of the Galapagos, reaching over 1700 fathoms in a distance of less than 50 miles, when the bottom remained comparatively flat, attaining a depth of 2000 fathoms about 100 miles farther south. This depth we carried eastward on a line to Aguja Point, until half-way the soundings had increased to over 2200 fathoms and remained at about that depth to within 60 miles of the coast, when the depth rapidly shoaled. From Aguja Point we ran a line of soundings to the southwest to a point about 675 miles west of Callao; on this line the depths gradually increased from 2200 fathoms, 100 miles off the Point, to nearly 2500 fathoms. On running east to Callao the depth soon increased to about 2600 fathoms, and at a distance of about 80 miles off Callao we dropped into the Milne-Edwards Deep and found a depth of over 3200 fathoms. We spent a couple of days in developing this deep, making soundings of 1490, 2845, 458, 1949, 2338, and 3120 fathoms; showing a great irregularity of the bottom within a comparatively limited area of less than sixty miles in diameter. Thus far all our soundings have been made with the Lucas sounding-machine.

In the Panamic basin to the northeast of the Galapagos we only trawled off Mariato Point, but we occupied ten stations with the tow nets, hauling both at the surface and at 300 fathoms, and vertically from that depth; we also continued this pelagic work at nearly all the stations (35) from the Galapagos to Callao.

When off Chatham Island we began to trawl and used the tow nets regularly, occupying twenty stations. The nets were in charge of Mr. F. M. Chamberlain. The pelagic collections, as a whole, are remarkably rich. They are especially noteworthy for the great variety and number of pelagic fishes obtained inside the 300-fathom line at a considerable distance from shore, — from 300 to 650 miles. Many of these fishes had been considered as true deep-sea fishes to be obtained only in the trawl when dredging between 1000 and 1500 fathoms or more. On one occasion the tow net brought up from 300 fathoms, the depth being 1752 fathoms, no less than 12 species of fishes; of one species of Myctophum we obtained 18 specimens; of another, 37; of a third, 45; in all, nearly 150 specimens. On other occasions it was not uncommon to obtain 8 or 10 species, and from 50 to 100 specimens. Among the most interesting types obtained in the tow net I may mention as coming from less than 300 fathoms, Stylophthalmus and Dissoma, both of which Chun considers as deep-sea fishes, found from 600 to 4000 metres; also a species of Eurypharynx obtained for the first time in the Pacific. Stylophthalmus I had also caught in a tow net in 1900, during the tropical Pacific Expedition of the "Albatross," in depths of less than 300 fathoms. In the lines we ran across the great northerly current which sweeps along the coast of Peru and Chili and is deflected westward at the easterly corner of the Galapagos Islands, we obtained with the tow nets an unusually rich pelagic fauna at depths less than 300 fathoms. We collected a number of Schizopods, among them many beautifully colored Gnathophausiae, pelagic Macrurans; huge, brilliant red Copepods, as well as many other species of blue, gray, mottled, and banded Copepods. Lucifer and Sergestes were abundant in many of our hauls. Many species of Amphipods were collected, Hyperids without number, especially where the surface hauls were made among masses of Salpae, which, on several occasions, formed a jelly of Tunicates. Several species of Phronimae also occurred constantly in the tow nets. Sagittae were very numerous, a large orange species being noteworthy. Several species of Tomopteris, some of large size and brilliantly colored, violet or carmine with yellow flappers, and two species of Pelagonemerteans. Two species of orange-colored Ostracods were also common, one having a carapace with a long spiny appendage. We obtained several species of pelagic Cephalopods, Cranchia and Taonis among them. Two species of Doliolum also occurred, but they were never as abundant as the Salpae, two species of which often constituted the whole contents of the tow net.

In the surface and deeper tows we also procured a number of Acalephs; we have thus far collected more than 50 species of Medusae and Siphonophores, many of which have been figured by Mr. Bigelow, differing from those of the 1891 Expedition. Atollae, and other deep-sea Medusae, were common within the 300-fathom line. The Salpae guts gave us, in addition to the finer tow nets, immense collections of Radiolarians, Diatoms, Dinoflagellata, many of which have been considered to live at great depth and upon the bottom. The number of Diatoms found in this tropical region is most interesting. They have usually been considered as characteristic of more temperate and colder regions. On several occasions the surface waters were greatly discolored by their presence, and the extent of their influence on the bottom deposits is shown by the discovery of a number of localities where the bottom samples at depths from 1490 to 2845 fathoms in the track of the great Peruvian current formed a true infusorial earth.

The tow nets also contained many species of Hyalea, Cymbulia, Styliola, Cleodora, Tiedemannia, Clio, and the like. On one occasion the mass of the pelagic hauls consisted entirely of small brown Copepods, the contents of the tow nets looking like sago soup. Another time Sagittae, Salpae, Doliolum and Liriope, all most transparent forms, formed the bulk of the tow net's catch. Again, Firoloides and Carinarias constituted the bulk of the haul. These catches, coming on successive days or interrupted with hauls of more than mediocre quality, show how hopeless it is at sea to make any quantitative analysis of the pelagic fauna and flora at any one station within the influence of such a great oceanic current as the Chilian and Peruvian stream.

Hauls of the trawl made at the western extremity of our lines brought us within the area of the manganese nodules, with its radiolarian ooze mud, shark's teeth, Cetacean ear-bones and beaks of Cephalopods; nothing could stand the damaging work of these nodules in grinding to pieces all the animal life the trawl may have obtained. Down to the depth of 2200 fathoms or so the bottom was covered by Globigerina ooze, its character being more or less hidden when near the coast by the amount of detrital matter and terrigenous deposits which have drifted out to sea.

North of the Galapagos we found vegetable matter at nearly all the stations, and between the Galapagos and Callao such material was not uncommon in the trawl.

Beyond the line of 2200 fathoms dead Radiolarians became quite abundant on the bottom, as well as in the mud of the manganese nodules, though among the nodules it was not uncommon to find an occasional Biloculina. Many of the dead Radiolarians found on the bottom Professor Kofoid found in the guts of Salpae swimming near the surface or within the 300-fathom line in the tow nets sent to that depth. The same is the case with many of the Dinoflagellata which had been considered as deep-sea types. In our tow nets from 300 fathoms we found very commonly Tuscarora, Tuscarosa, Aulospira, and others. In depths of 300 fathoms to the surface the tow net was rich in Tintinnidae, either dead or moribund Planktoniellae, and Dinoflagellata. Among the Dinoflagellata there were 10 species of Ceratium, 9 of Peridinidae, Gonyaulax, Phalacroma, Pyrocystis, Cyttarocylis, Undella, and Dictiocystus. On the surface Planktoniella sol predominates with Asteromphale, Biddulphia, and Synidia thalassothrix; among the Dinoflagellata we obtained 12 species of Ceratium, 5 of Peridinium, and 22 species of other Peredinidae.

Among the Tintinnidae were a number of Sticholonche; among the Acantheriae were specially to be noticed Acanthometra, Acanthostaurus, Amphilonche, Collozoum, Thalassicola, and a number of Chirospira murrayana, and a few Challengeridae.

Our trawls brought up from the bottom many interesting fishes, among which I may mention Bathypterois, Ipnops, a few bat fishes, all species thus far described by Mr. Garman from the 1891 Expedition. I may also mention a Chimaera, different from the Chili species. The fish have been admirably cared for by Dr. J. C. Thompson, U.S.N. Among the Crustacea: Lithodes, Munidopsis, and many Macrurans, all well-known species of the 1891 Expedition. We found a few Mollusks, and a few interesting genera of tubicolous Annelids. Compared to the 1891 Expedition, few starfishes and brittle stars were obtained, and still fewer sea urchins, only one species of Aceste and one of Aërope, a marked contrast to the numerous Echini collected in the Panamic basin in 1891. We obtained, however, a magnificent collection of Holothurians; nearly every species occurring in the Panamic basin being found in numbers in our track south of the Galapagos, in the wake of the great Chilean-Peruvian current and at considerable depths. On one occasion, at Station 4647, in 2005 fathoms, we obtained no less than 16 species of Holothurians, among them brilliantly colored Benthodytes, Psychropotes, Scotoplanes, Euphronides, and the like. At Station 4670, in 3209 fathoms, we obtained 6 species of Holothurians. At Station 4672, in 2845 fathoms we also obtained very many specimens of three species of Ankyroderma, a large Deima, 2 species of Scotoplanes, 2 of Psychropotes, with a number of young stages of that genus; repeating thus the experience of the "Challenger," which found Holothurians in abundance at great depth, not only in the number of specimens, but also of species, though the "Challenger" did not at any locality obtain as many as we did at Station 4647. Mr. Westergren made a number of colored sketches of the species which were not obtained in the 1891 Expedition. We also collected in the trawl a number of deep-sea Actinians, none different, however, from genera found previously in the Panamic district. We also obtained a few Pennatulids, Gorgonians, and Antipathes, and a very considerable number of siliceous Sponges, usually associated with the Holothurians found in deep water in the track of the Peruvian current. In the track of the current at not too great distances from the coast we invariably brought, even from very considerable depths, sticks and twigs and fragments of vegetable matter. On two occasions we brought up in the trawl specimens of Octacnemus. The trawl had been working at 2235 and at 2222 fathoms. Both Moseley and Herdman described this interesting Ascidian as attached to the bottom by a small peduncle. While the presence of the peduncle cannot be denied, yet its attachment, if attached at all, must be of the slightest. Its transparent slightly translucent body, with its eight large lobes, suggesting rather a pelagic type than a sedentary form. This Ascidian was discovered by the "Challenger" west of Valparaiso.[1]

Mr. Chamberlain made two daily observations of the density of the water, and found the same discrepancies between our observations and those of 1891 with those given by the "Challenger" and in the Deutsche Seewarte Atlas of the Pacific Ocean. Whenever we took a serial temperature, he also determined the density at 800 fathoms. We occupied six stations for the serial temperatures, two on the western termini of the lines normal to the coast across the great Peruvian current, two in the centre of the current, and two at a moderate distance from the coast. These serials developed an unusually rapid drop in the temperature between the surface and 50 fathoms, nearly 12°, at the western extremity of the northern line, the temperature having dropped from 71.7° at the surface to 59.2°. At 200 fathoms it was 51°, and at 600 fathoms it had dropped to 40.7°, the bottom temperature at 2005 fathoms being 36.4°. The temperature of the station in the central part of the current in 2235 fathoms agreed with the western series. At the eastern part of the line in 2222 fathoms, with a bottom temperature of 36.4°, the surface being only 67°, we found again a close agreement at 50 and 100 fathoms, the lower depths at 400 and 600 fathoms being from one to two degrees warmer than the outer temperatures. On taking a serial from the surface to 100 fathoms, we found that the greatest drop in temperature took place between 5 and 30 fathoms.

The temperatures of a line running due west from Callao showed a very close agreement both at the western end of the line about 780 miles from the coast and in the central part of the line, as well as in the shore station about 80 miles from the coast in 3209 fathoms. The bottom temperature in nearly all the depths we sounded was 36°, a high temperature for that depth. I do not make at present any comparison with the serials taken in the Panamic district in 1891 until we shall have completed our lines to the south and to the west.

We leave for Easter Island on the 3d of December, where we shall coal, and go from there to the Galapagos and thence to Manga Reva and Acapulco, where we ought to arrive in the early days of March.

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[1] In the Albatross Tropical Pacific Expedition (1899–1900) Octacnemus was obtained in the tow net from less than 150 fathoms at Station 15, Lat. 4° 35′ N., Long. 136° 54′ W.

The changes made in the working apparatus of the "Albatross" under the superintendence of Lieutenant Franklin Swift, U. S. N., have proved most satisfactory. The changes made in the main drum and the device for preventing the piling of the wire on the surging drum and the accompanying shock have greatly reduced the risk of breaking the wire rope when trawling at great depths. The wire rope has proved an excellent piece of workmanship, and has worked admirably in the comparatively deep water in which most of our trawling has been done thus far. A new dredging-boom has also been installed, and everything relating to the equipment of the "Albatross" has been carefully overhauled.

Lieutenant-Commander L. M. Garrett has been indefatigable in his interests for the expedition, the officers and crew have been devoted to their work, and the members of the scientific staff have carried out most faithfully their duties of preparing and preserving the collections thus far made.

We hoped to be docked at Callao, but owing to the prolonged occupation of the dock by a disabled steamer, and the uncertainty of its becoming free within reasonable time, we decided to proceed without further delay to Easter Island and continue the expedition as we are.

II.

CHATHAM ISLAND, GALAPAGOS, January 6, 1905.

We left Callao for Easter Island Saturday afternoon, December 3; as far as 90° western longitude we remained in the Humboldt current, as we could readily see from the character of the temperature serials and from the amount of pelagic life we obtained both from the surface and the intermediate hauls. This also affected the bottom fauna, which was fairly rich even as far as 800 miles from the shore as long as we remained within the limits of the northern current. As soon as we ran outside of it the character of the surface fauna changed; it became less and less abundant as we made our way to Easter Island, the western half of the line from Callao to Easter Island becoming gradually barren. This also affected the deep-sea fauna to such an extent that towards Easter Island, at a distance of 1200 to 1400 miles from the South American continent, our trawl hauls were absolutely barren; the bottom for the greater part of the line being covered with manganese nodules on which were found attached a few insignificant siliceous Sponges, an occasional Ophiuran, and a few Brachiopods or diminutive worm tubes; the same bottom continuing to Sala y Gomez and between it and Easter Island. Sala y Gomez and Easter Island are connected by a ridge on which we found 1142 fathoms near Sala y Gomez, and 1696 fathoms between it and Easter Island. The ridge rises rapidly from about 2000 fathoms, the general oceanic depth within about 100 miles, to over 1100 fathoms within a comparatively short distance from both Sala y Gomez and Easter Island.

The southern part of our line from Easter Island to the Galapagos shows all the characteristic features of the western part of the line from Callao to Easter Island: like it, as far as the 12th degree of southern latitude, it proved comparatively barren, the bottom consisting of manganese nodules to within about 250 miles of the Galapagos. The pelagic and intermediate fauna from Easter Island to 12° south latitude was very poor, and the serial temperatures show that we were outside and to the westward of the great Humboldt current. But near the 12th degree of southern latitude a sudden change took place; the pelagic and intermediate fauna became quite abundant again, and soon fully as rich as at any time in the Humboldt current. There was also a marked change in the temperature of the water as shown by the serials; showing that from the 12th degree of southern latitude to the Galapagos we were cutting across the western part of the Humboldt current. The great changes of temperature which took place in the layers of the water between 50 and 300 fathoms are most striking, and show what a disturbing element the great mass of cold water flowing north must be in the equatorial regions of the Panamic district to the south and to the north of the Galapagos. South of the Galapagos the western flow of the Humboldt current must be nearly 900 miles wide and of about the same width when running parallel to the South American coast.

The range of temperatures between 30 and 150 fathoms is at some points as great as 21°. Such extremes cannot fail to affect the distribution of the pelagic fauna, and may account for the mass of dead material often collected in the intermediate tows when hauling at depths of less than 300 fathoms, when the range becomes as great as 28°. Such a range of temperature is far greater than that of the isochrymic lines which separate coast faunal divisions. The bottom fauna, as we entered the Humboldt current going north, gradually became richer in spite of its being covered with manganese nodules.

The two lines centring at Easter Island developed the "Albatross" plateau indicated on the "Challenger" bathymetrical charts, on the strength of a few soundings reaching from Callao in a northwesterly direction, and of a couple of soundings on the 20th degree of latitude. The Albatross plateau is marked as a broad ridge separating the Buchan Basin from the deep basin to the westward, of which Grey Deep and the Moser Basin are the most noted areas.

Our line from Easter Island to the Galapagos showed a wonderfully level ridge, varying in depth only from 2020 to 2265 fathoms in a distance of nearly 2000 miles. The soundings we made to the eastward from the Galapagos to the South American coast, and to the westward of Callao, as well as on the line from Callao to Easter Island, all indicate a gradual deepening to the eastward to form what the "Challenger" has called the Buchan Basin with a greatest depth of 2400 to over 2700 fathoms, and passing at several points near the coast to Milne, Edwards, Krümmell, Richards and Haeckel Deeps, some of them with a depth of over 4000 fathoms. According to the "Challenger" soundings, the Juan Fernandez plateau connects with the Albatross plateau, and forms the southern limit separating Buchan Basin from the Barker Basin to the south of the Juan Fernandez plateau.

At Easter Island we found our collier awaiting our arrival. We moved from Cook Bay to La Pérouse Bay to coal, as there was less swell there than in Cook Bay, where we could scarcely have gone alongside to take in coal.

Considerable shore collecting was done at Easter Island. We must have brought together at least 30 species of plants. The flora of Easter Island is very poor. There are no trees nor native bushes — not even the bushes which characterize the shore tracts of the most isolated coral reefs of the Pacific are found there; and yet some of the equatorial counter currents must occasionally bring flotsam to its shores. We collected a number of shore fishes and made a small collection of the littoral fauna. The fishes have a decided Pacific look, and the few species of sea urchins we came across are species having a wide distribution in the Pacific.

While coaling, we spent some time examining the prehistoric monuments which line the shores of Easter Island. During our stay at La Pérouse Bay we visited the platforms studding the coast of the bay, and made an excursion to the crater of Rana Roroka, where are situated the great quarries from which were cut the colossal images now scattered all over the island, many of which have fallen near the platforms upon which they were erected. Near Rana Roroka, at Tongariki, is the largest platform on the island, about 450 feet in length, to the rear of which are fifteen huge images which have fallen from the pedestals upon which they once stood. The plain in the rear of the platform is crowded by stone houses, most of which are in ruins.

On our return to our anchorage at Cook Bay, we examined the platforms within easy reach of the settlement, and also the crater of Rana Koa, on the north rim of which, at Orongo, are a number of the stone houses built by the people who quarried the great stone images. At Orongo are also found sculptured rocks, but neither the sculptures nor the images show any artistic qualities, though the fitting of some of the cyclopean stones used in building the faces of the platforms indicate excellent and careful workmanship. To Mr. C. Cooper, manager of the Easter Island Company, we are indebted for assistance while visiting the points of interest of the island. He was indefatigable in his exertions in our behalf.

We took a number of photographs during our stay, illustrating not only the prehistoric remains, but giving also an idea of the desolate aspect of Easter Island during the dry season.

We arrived at Wreck Bay, Chatham Island, Galapagos, on the third of January, where we found a schooner with a supply of coal. As soon as the ship has been overhauled and coaled we shall start for Manga Reva, where we ought to arrive the last days of January. We reached Chatham Island towards the end of the dry season. Everything is dried up, the vegetation seems dead with the exception of a few small wild cotton plants, weeds, cactus, and an occasional Mimosa; and the great barren slopes present fully as uninviting an aspect as when Darwin described them. When the "Albatross" visited the Galapagos in March, 1891, everything was green, presenting a very marked contrast to its present desolate appearance.

III.

ACAPULCO, MEXICO, March 26, 1905.

We left the Galapagos (Wreck Bay) for Manga Reva the 10th of January.

On the northern part of this line we did but little work beyond sounding, as we were likely to duplicate our former work to the eastward. The fourth day out, in latitude 5° S., we began a series of trawl hauls, surface and towing to 300 fathoms. In the northern part of the line to Manga Reva the hauls were remarkably rich as long as we remained within the influence of the western extension of the Humboldt current, and as long as there poured from the surface masses of the Radiolarians, Diatoms, and Globigerinae living at or near the surface. Some of the hauls were remarkable for the number of deep-sea Holothurians and siliceous Sponges. Among the former I may mention a huge Psychropotes, 55 c. m. long.

As we passed south and gradually drew out of the influence of the western current, we entered the same barren region we passed through to the eastward when going to and from Easter Island. By the time we reached latitude 15° S., the hauls became quite poor, and this barren bottom district extended to within a short distance of Manga Reva; corresponding to it near the surface we found a most meagre pelagic fauna, both at the surface and down to 300 fathoms — so poor that it could afford but little food to the few species, if any, living on the bottom in that region.

We arrived at Manga Reva on the 27th of January and found our collier awaiting our arrival.

While at anchor in Port Rikitea, we examined Manga Reva, the principal island of the Gambier group, from its central ridge on the pass leading from Rikitea to Kirimiro on the west side of Manga Reva, as well as from the pass leading to Taku. On both these passes we obtained excellent views of the "barrier reef" to the west, north, and east of the Gambier Islands, and we could trace in the panorama before us the western reef extending in a northeasterly direction parallel to the general trend of Manga Reva Island for a distance of about 5½ miles.

From the northern horn to nearly opposite Kirimiro Bay the barrier reef has only three small islets. It is narrow, of uniform width (about ⅓ of a mile), plainly defined, submerged in places, and passing north bounds a large northern bight dotted with numerous interior coral patches from a quarter of a mile to a mile in diameter or length, with from 7 to 11 fathoms. The southern part of the western barrier lagoon off Manga Reva is irregularly dotted with many small patches of reef, with an occasional deep hole near Manga Reva Island of from 15 to 20 fathoms. From the islet to the west of Kirimiro there are but few coral patches, indicating a reef which dips gradually in a distance of a mile to a deeper channel of from 4 to 6 fathoms, which separates the northern and western reef from the great reef flat lying to the southwest of Tara Vai. This flat has a width of nearly 2 miles, it is about 4½ miles long, and is marked at its southwest extremity by a series of low islets arranged in a somewhat circular line, formed by 8 deep bays and spurs from the outer line of islets, as so frequently occurs on wide reef flats in atolls of the Pacific.

This part of the reef is called Tokorua. This reef flat shelves very gradually from 3½ to 4 fathoms on the west face to 7, and connects with the "plateau" upon which stand Tara Vai and Aga-kanitai. From Tokorua the reef extends in an indefinite narrow ridge 8 miles long, with from 3 to 8 fathoms, in a southeasterly direction. The western edge is steep to, and the eastern face passes gradually into the lagoon, which at that point has a general depth of 8 to 20 fathoms; the deepest part of this region being at the foot of Mt. Mokoto between it and Tara Vai, though Tara Vai is united with Manga Reva Island by a plateau varying in depth from 3½ to 4½ fathoms.

At the southeastern point of the reef it passes into a wide plateau with from 9 to 10 or 15 fathoms. The plateau is about 9 miles wide southwest of Tekava. That part of the atoll has not been well surveyed, so that the position of the reef flat has not been ascertained further west on that part of the east face; but the southeast passage indicates 5½, 6, and 6½ fathoms where it probably marks the southwestern extension of the eastern barrier reef, separating the lagoon from the southern plateau to the south of the encircling reef.

The western faces of Manga Reva and of Tara Vai are indented by deep bays, formed by spurs running from the central ridge of these islands, the remnants probably of small craters which flanked the large crater, of which Manga Reva forms the western rim and Au Kena is the remnant of the southeastern edge, the former extension of this rim being indicated by the spits uniting the base of Mt. Duff with Au Kena, and by the projection of Au Kena towards the outer barrier reef, and by the numerous patches of coral reef off the northeast point of Manga Reva towards the outer line of Motus till they almost unite with the barrier reef.

The whole of the western bays of Manga Reva Island are filled by fringing reefs which leave but here and there a deeper pass to the shore. The south face at the foot of the bluff of Mt. Mokoto and Mt. Duff is edged by a flourishing, fringing reef extending nearly half a mile on the plateau at their base. The port of Rikitea is a reef harbor formed within the large fringing reef which occupies the whole of the southern bay of Manga Reva Island. The east face of Tara Vai and part of the east and of the west face of Aga-kanitai are also fringed by reefs.

The islets and islands of Aka Maru, Mekiro, and Maka-pu are within a fringing reef flat which runs around the west face of Aka Maru; Au Kena is also edged by an extensive fringing reef which runs out in a spit of more than half a mile, in a northeasterly direction almost to the outer line of Motus, which are nearly united with it by irregular patches. To the west of Au Kena a huge spit of 2 miles in length extends towards the base of Mt. Duff and almost unites with the fringing reef off the Cemetery, leaving a narrow but deep pass for the entrance of ships into the inner harbor of Rikitea. There is only from 1 to 2¾ fathoms of water on these two spits.

The depth of the basin within this area with from 25 to 31 fathoms would be naturally explained as being part of an ancient crater, as in Totoya in Fiji; its northeastern rim is also perhaps further indicated by the comparatively shallow flat of the lagoon to the west of the barrier reef, with from 5 to 11 fathoms of water.

The principal islands of the group are in the central part of the lagoon. The four larger islands are Manga Reva, Tara Vai, Au Kena, and Aka Maru. Tara Vai is flanked by Aga-kanitai and another islet to the west called Topunui; Aka Maru is flanked by Mekiro to the north, and by Maka-pu to the south. The southeast face of Aka Maru is an extinct crater, of which Maka-pu forms the south rim. The main ridge of Tara Vai is the edge of parts of three craters now opening to the west. The four small volcanic islands in the southern part of the lagoon are isolated fragments, steep to, greatly weathered, and disintegrated. No soundings exist to show their relation to the other islands of the group.

The soundings thus far made indicate in the southern part of the lagoon a depth of about 23 fathoms, with an occasional hole of from 38 to 40, and a gradual slope towards the outer sunken reef. To the south of the old crater of Manga Reva the general depth of the banks varies from 6 to 11 fathoms, with a deeper channel varying from 20 to 40 from southwest of Au Kena towards Tara Vai. The lagoon seems to form a western basin where the depth varies from 10 to 20 fathoms. To the west of Au Kena and Aka Maru, lying between them and the line of the outer barrier reef islets. A similar but shallower basin exists, off the northern end of Manga Reva, between it and the northern horn of the barrier reef, with from 7 to 11 fathoms. Its rim is formed by a ring of reef patches of very varying size.

On two occasions we visited the outer barrier reef and examined the outer line of islets of the eastern face of the Gambier Islands. The position of the islets as marked on the chart is not that of to-day, and the position of the reef flats is not correct. The position of Tekava and Tauna appears to be correct. Opposite Au Kena and in its extension the east face of the barrier reef projects sharply to the east, forming an angular horn, with one island south of the horn and the other north running at a sharp angle with it, so as to form a triangle which makes a deep bight opening westward to such an extent that when off the northern side of the horn we could see Tekava far to the westward of it. The second island is followed by a third, and then by a long island — Tarauru-roa — nearly 2 miles long; these are separated by small gaps. Then comes a larger island — Amou — followed by three small islands separated by deep gaps.

At Vaiatekeue (not the Vaiatekeua on the chart), the reef flat becomes quite narrow, it is hardly more than 100 yards wide, the islets perhaps 50. The northern islets are small and separated by long stretches of low shingle, and carry but little vegetation and very few cocoanut trees. There are but two short sand beaches all the way from the northeastern to the eastern horn of the eastern face of the encircling reef of Manga Reva. A regular dam of shingle from 10 to 14 feet high, on the top of which the usual coral reef vegetation flourishes, extends along the outer face of the reef flat, which varies from 50 to 150 yards in width, and is flanked at the base by low buttresses of modern elevated coral reef rock and of breccia in places all more or less weatherbeaten and honeycombed.

The islets, and their formation, and their junction or separation into larger or smaller islets, and the gaps which separate them, the mode of formation of the buttresses, of the planed-off, hard, nearly level reef flat, of the coralline mounds of the outer edge, — all these differ in no way from what has been described in other barrier reef islands and atolls of the Pacific.

The beaches of the lagoon are steep, and corals do not seem to thrive in those parts of the lagoon to which the sea does not have access or at some distance from shore. This is well shown by the vigorous growth of corals in the fringing reef to the south of Mt. Duff on the outer edges of the reef patches of Port Rikitea, and on the spits which connect Au Kena with Manga Reva, contrasted to those along the west face of the lagoon flats to the west of the eastern barrier reef.

There is a northeast horn of the eastern barrier reef in the extension of Manga Reva Island, forming the northern culmination of the central bight of the eastern face of the barrier reef. From that point the reef flat runs westerly to form the northern horn about 3 miles north of Manga Reva Island. The position of the outer reef cannot be correct on the chart (H.O.2024). On leaving Manga Reva, we made three soundings close off the reef flat line of breakers, — one off Tekava, at the most one-third of a mile from the reef, in 225 fathoms. Our position plotted by tangents to the volcanic islands or by their summits indicated in this case, on the chart, a distance of 1½ miles. A second sounding of 245 fathoms off the eastern horn at less than one-half mile, indicated on H.O. chart 2024 a distance of 2 miles from the horn; and a sounding of 241 fathoms one-fourth of a mile off the point which we had visited (Vaiatekeue) indicated a distance of three-fourths of a mile on the chart.

The slope of the Gambier archipelago to the east is steep. On coming in sight of Manga Reva we sounded in 2070 fathoms at a distance of 11 miles from Mt. Duff, that is, 6 miles from the outer edge of the reef bearing southwest; and on coming out we sounded again half-way to that point at a distance of 3¼ miles from the breakers in 1394 fathoms.

One cannot fail to be struck with the similarity of the Manga Reva archipelago to the great atoll of Truk. If I remember rightly, Darwin also called attention to this from a study of the charts. Yet, owing to the great size of Truk, no less than 125 miles in circumference, and the great distance of the barrier reef from the encircled volcanic islands, the effect as one steams into Manga Reva is totally different from that produced by Truk. In the latter some of the islands, though large, and of the same height as those of Manga Reva, are much more scattered, and seem of comparatively small importance in the midst of the huge lagoon which surrounds them. The barrier reef islets of Truk are from 11 to 15 miles distant from the encircled volcanic islands. In Manga Reva, which is only 45 miles in circumference, after passing the small islands in the southern and open part of the lagoon when once off Maka-pu, we can fairly well take in the atoll as a whole. The western island (Tara Vai) is only 5 miles off; Manga Reva and Au Kena are about 3, as are also the islets of the east face of the barrier reef. These distances, as you approach the entrance to Rikitea, are constantly growing less, so that when in the gap between Manga Reva Island and Au Kena, at the foot of Mt. Duff, none of the larger islands are more than 3 miles off; and the islets of the eastern face of the barrier reef are seen to the northeast about 4 miles off. When on the summit of the central ridge of Manga Reva, one can, in a radius of a little more than 4 miles, take in the whole panorama of Manga Reva, and get an impression of the relations of its different parts far better than it can be conveyed by the chart, for the whole of the visible part of the archipelago is included in a line drawn east and west, south of Maka-pu; south of that line the position of the southwestern reef can be traced only by the discoloration of the water.

Manga Reva is an intermediate stage of erosion and denudation between an archipelago lagoon such as Truk and a barrier reef island like Vanikoro, and other islands in the Society group, as Bora Bora,[1] Huaheine, Raiatea, Eimeo, in which the surrounding platform has comparatively little width and the barrier reef is close to the principal island and often becomes a part of its fringing reef. Manga Reva is open to the south and to the west, Vanikoro to the east, while the volcanic islands of Truk are completely surrounded by the outer encircling barrier reef, as are the Society Islands just mentioned, which have several wide passages into the lagoon through the wide barrier reef.

One is tempted to reconstruct the Gambier Archipelago of former times, and to imagine it with a great central volcano, with a deep crater of more than 34 fathoms, of which Manga Reva and Au Kena are parts of the rim which once were connected from the southeast point of Manga Reva to Au Kena, and thence along the line of the outer islets to the northeast end of the former island. On the west face it was flanked by smaller craters extending to the western islets of the barrier reef of which the bays of Taku, Kirimiro, and Rumaru, and the bays of the west side of Tara Vai are the eastern ridges. There were probably also other secondary volcanoes, of which Aka Maru and the islets of the south part of the lagoon are the remnants, the latter all being situated on the gentle slope of the southern part of the Manga Reva plateau; this may have been the southern slope of the principal volcano of the group on the face of which have grown up the outer line of the barrier reef and its islets.

The existence of a central volcano with a deep crater would readily explain the great depths of the lagoon in its different regions, and off the outer face of Manga Reva, depths showing slopes which are no steeper nor more striking than the heights and slopes of the southern part of Manga Reva, of Tara Vai, of Aka Maru, and of Maka-pu; supposing them to be extended into the sea.

Mt. Mokoto and Mt. Duff drop precipitously for more than one-third their height, and in less than a quarter of a mile fall from over 1300 feet to the level of the sea. Similar slopes are found along the volcanoes of Easter Island where there are no coral reefs. The edge of the crater of Rana Kao drops perpendicularly a height of nearly 1000 feet in less than one-eighth of a mile horizontal distance; and the eastern face of the crater of Rana Roroka rises vertically about 800 feet above the plain of Tangariki.

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[1] See A. Agassiz. The Coral Reefs of the Tropical Pacific, Plates 210 and 231.

It is interesting to note how poor is the flora of the Manga Reva archipelago as compared with that of the more western volcanic islands like the Marquesas and the Society Islands and some of the western elevated Paumotus. In the Gambier Archipelago the forests are reduced to a few patches extending along the small valleys of the slopes of the volcanic spurs. I am informed that even in the thirties of the last century, when the missionaries first landed at Manga Reva, the forest trees while more numerous yet never attained the luxuriance of growth that they attain in the Society and Marquesas Islands. At the present day, with the exception of the forest patches just mentioned and a few trees which have been introduced for cultivation, the islands of the group are in great part thickly covered with a species of cane closely resembling that of our southern States. It grows to a height of nearly 10 feet. The fauna of Manga Reva is also extremely poor. There are no mammals, and, with the exception of a "sandpiper," no indigenous birds. Sea birds are few in number, and in our trip in the eastern Pacific we rarely had more than three or four birds accompanying us; often only one, and frequently none were visible for days. There are a few lizards on the islands, apparently the same species as those in the Society Islands.

We left Port Rikitea for Acapulco on the 4th of February to anchor off Aka Maru; on the 5th we left our anchorage, sounded off the east face of Manga Reva, and took photographs.

On our way north from Manga Reva to Acapulco we did not begin to trawl or tow until warned by the surface nets that the surface was becoming richer in animal and vegetable life, and also by the surface temperatures indicating that we had reached the southern edge of the cold western equatorial current. A little north of 10° south latitude we made our first haul and deep tow, and found a very rich pelagic surface fauna down to the 300-fathom line; recalling the pelagic fauna of the eastern lines and fully as rich. On trawling we found, as we expected, a very rich bottom fauna.

Among the animals brought up in the trawl were some superb Hyalonemas, siliceous Sponges, Benthodytes, and other deep-sea Holothurians; fine specimens of Freyella, and some large Ophiurans. This haul is interesting as showing that in the tract of a great current, with abundance of food, we may find at a very considerable depth (2422 fathoms) an abundant fauna at very great distances from continental lands. We were, at this station, about 2140 miles from Acapulco, 1200 miles from Manga Reva, 1700 miles from the Galapagos, and about 900 miles from the Marquesas.

Another haul made under the equator, near the northern edge of the cold current, in 2320 fathoms, gave us the same results. The pelagic life was very abundant, the surface teemed with Radiolarians, Diatoms, and Globigerinae, and swarmed with invertebrates. The trawl contained a superb collection of Holothurians, Brisinga, Hyalonema, Neusina, and on this occasion we brought up the only Stalked Crinoid collected during this expedition, parts of the stem of two specimens of Rhizocrinus, of which, unfortunately, the arms were wanting.

Our progress, which had been excellent during the first days of our journey after leaving Manga Reva, has for the past six days been greatly impeded by head winds in the region where we ought to have been in the full swing of the southeasterly trades. This led us with great reluctance to abandon all idea of further work in the equatorial belt of currents, to give up our proposed visit to Clipperton, and on account of our limited coal supply to make for Acapulco, merely sounding every morning. This was a great disappointment to me, as we had every reason to expect to be able to spend some time in the belt of the equatorial currents, and settle more conclusively than we have been able to do, the question of their influence upon the richness of the fauna living in their track far from continental shores or insular areas.

The presence of Diatoms in all parts of the Humboldt current which we crossed from south of Callao to the equator at the Galapagos, and west towards Clipperton, shows how far the tract of a great oceanic current can be traced, not only by its temperature, but also by the pelagic life living upon its surface or near it. When once in the warm westerly equatorial current, the Diatoms disappear and the bottom samples show only surface Radiolarians and Globigerinae.

We took a number of serial temperatures in the line Galapagos to Manga Reva, passing from the colder water of the Humboldt current to the warmer waters south toward Manga Reva. The temperatures at 200 fathoms became nearly identical. North the great change in temperature took place between 25 and 200 fathoms, where there was a difference of 24°. South the warm water extended to 100 fathoms, a great change occurring between 100 and 200 fathoms, a drop of 16°. The serial temperatures taken at the southern and northern edges of the cold current on the line Manga Reva to Acapulco agreed well with those taken in the same current to the east.

The samples of the bottom obtained by the soundings taken by the expedition or gathered in the mud-bag and in the trawl indicate that an immense area of the bottom of the eastern Pacific is covered by manganese nodules, and that they play an important part in the character of the bottom, not only in the area covered by this expedition, but also that the area of manganese nodules probably extends to the northwest of our lines to join the stations where in 1899 manganese nodules were found by the "Albatross" in the Moser Basin, on the line San Francisco to Marquesas. This area may also extend south of our line Callao to Easter Island, and join the line west of Valparaiso where the "Challenger" obtained manganese nodules at many stations. I do not mean to imply that the manganese nodules are present to the exclusion of Radiolarians and of Globigerinae. It is probable that the layer of nodules is partly covered by them, and by the thick sticky dark chocolate-colored mud which is found wherever manganese nodules occur.

During this expedition we sounded every day while at sea, and developed very fairly that part of the eastern Pacific which lies to the south and west of the line from Cape San Francisco to the Galapagos and west of a line Galapagos to Acapulco, limiting an area occupied by the "Albatross" in 1891. The area developed by us is included by a line 3200 miles in length from Acapulco to Manga Reva, and north of a line from Manga Reva to Easter Island and from Easter Island to Callao. We developed on our line Galapagos to Manga Reva the western extension of the Albatross plateau, and found it of a depth varying from 1900 to somewhat less than 2300 fathoms in a distance of nearly 3000 miles; but about half-way from the Galapagos to Manga Reva we came upon a ridge of about 200 miles in length with a depth of 1700 to 1055 fathoms, dropping rapidly to the south to over 1900 fathoms. I propose to call this elevation the "Garrett Ridge."

Our line from Manga Reva to Acapulco continued to show the western extension of the almost level bottom of the eastern Pacific. In a distance of 3200 miles the depth varied only about 400 fathoms. This great area of the eastern Pacific was practically a *mare incognitum*. Three soundings in latitude 20° S. toward the Paumotus and five soundings in a northwesterly trend from Callao to Grey's Deep are all the depths that were previously known in this great expanse of water.[1] The existence of the great plateau dividing Barker Basin along the South American coast from Grey and Moser Basins to the west is most interesting. It recalls the division of the southern Atlantic into an eastern and western basin by a central connecting ridge (The Challenger Ridge). The Albatross plateau joins the western extension of the Galapagos plateau, as developed by the "Albatross" in 1891.

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[1] These soundings were made (one) by the Italian S. "Vittor Pisani" in 1882; (three) by the "Silverton" in 1893; (four) by the U. S. S. "Alaska," and two east of the Paumotus by the H. B. M. S. "Alert."

The existence of a sounding of 2554 fathoms near the equator in longitude 110° W. would seem to indicate a small basin included in this plateau, disconnected from Grey's Deep and Moser Basin by its extension to the west. How far west towards these basins that extension reaches, no soundings indicate as yet. It is interesting to note that along the Mexican coast there are a number of deep basins lying disconnected close to the shore, just as there are a number of disconnected deeps close to the South American coast extending from off Callao to off Caldera, Chili, opposite high volcanoes or elevated chains of mountains. These basins are deeper than the Albatross plateau to the south, and form a deep channel separating in places the plateau from the steep continental slope. The steepness of a great part of the Mexican continental shelf is well seen, especially off Acapulco and Manzanilla. One of the small basins along the Mexican coast with 2661 fathoms lies off Sebastian Viscaino Bay; another with more than 2900 fathoms is to the west of Manzanilla Bay; a third to the southeast of Acapulco has about the same depth,[1] and a fourth with 2500 fathoms is off San Jose, Guatemala. These basins off the west coast, close to the shore and at the foot of a steep continental slope, are in great contrast to the wide continental shelves which characterize the east coast of Central America and the east coast of the United States.

The collections made during the present expedition will give ample material for extensive monographs on the Holothurians, the siliceous Sponges, the Cephalopods, the Jelly-fishes, the pelagic Crustacea, Worms and Fishes of the eastern Pacific, as well as on the bottom deposits and on the Radiolarians and Dinoflagellates, Diatoms, and other Protozoa collected by the tow nets. Small collections of plants were made at Easter Island and Manga Reva which may throw some light on the origin and distribution of the flora of the eastern Pacific.

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[1] The last sounding we made off Acapulco in 2474 fathoms 29 miles south of the Light House showed the western extension of this deep hole.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
K. BRANDT. The Sagittæ.
" The Thalassicolæ.
C. CHUN. The Siphonophores.
" The Eyes of Deep-Sea Crustacea.
W. H. DALL. The Mollusks.
H. J. HANSEN. The Cirripeds.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
HAROLD HEATH. Solenogaster.
R. VON LENDENFELD. The Phosphorescent Organs of Fishes.
H. LUDWIG. The Starfishes.
J. P. McMURRICH. The Actinarians.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.
" The Annelids.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., and XXXI.

Vols. XLIII., XLVI., and XLVIII. of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., XXXII., and XXXIII. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

These publications are issued in numbers at irregular intervals; one volume of the Bulletin (8vo) and half a volume of the Memoirs (4to) usually appear annually. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Librarian of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XLVI. No. 7.

NOTES ON BERMUDIAN FISHES.

By Thomas Barbour.

With Four Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
September, 1905.

No. 7. — *Notes on Bermudian Fishes.*[1] By THOMAS BARBOUR.

THE material which forms the basis for this paper belongs to the Museum of Comparative Zoölogy and is from several sources: first, a collection made by my brother, Mr. W. W. Barbour, and myself during parts of March and April, 1903; secondly, a large and rather complete collection made during part of June, July, and part of August, 1903, while I was attached to the Biological Station at Flatts, Bermuda; thirdly, a number of specimens in the collections of the Museum of Comparative Zoölogy, and finally, a series obtained by Professor Mark and collected at the Station during the summer of 1904. I here express my gratitude to Dr. Mark for his kindness in procuring a number of most interesting specimens, and thank Messrs. H. B. Bigelow, Owen Bryant, and J. T. Nichols, for their kind aid in collecting and preserving the largest collection. Finally, it is a pleasure to thank Mr. Samuel Garman of the Museum for the assistance he has giving me in making the identifications.

Before turning to a systematic consideration of the material in hand, a few words are necessary in explanation of the peculiar faunal conditions which obtain about the Bermuda Islands. In 1872 Dr. G. Brown Goode visited the Bermudas for several weeks (February to March), and made the first collections of any considerable size or value from this locality. He pointed out in his paper on the fishes (Goode **'76^a**) the splendid opportunity here presented to the ichthyologist for the study of the effects which the ocean currents have had in providing Bermuda with a fish fauna. He called attention to the fact that almost all the more characteristic fishes of the West Indian regions, and also many fishes which are found in the Azores, Canaries, Madeira, Cape de Verde Islands, and even on the coasts of Southern Europe and Africa are represented in Bermudian waters. One of the most interesting examples of distribution probably due to ocean currents is the occurrence of *Synodus saurus*, a fish which, on account of its sluggish, bottom-loving disposition, one would consider unlikely to range far from home. The majority of the species derived from distant regions, are, as Goode has pointed out, powerful and rapid swimmers. Few of the species which have been described as peculiar to Bermuda have remained so long. Both *Stolephorus choerostomus* and *Siphostoma jonesi* were once believed to be peculiar to Bermuda, but only a year or so ago the U. S. Fish Commission expedition to Porto Rico found both these species there. The Bermuda representatives were in all probability derived from the West Indian region. *Ulaema lefroyi* also is now known from many of the West Indies, and the Florida Keys.

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[1] **Contributions from the Bermuda Biological Station for Research. No. 6.**

The classic on the general Natural History of the Bermudas is Jones, Wedderburn, and Hurdis (**'59**); while more recently Verrill (**:02**) has published a most valuable and interesting volume dealing with the history, scenery, etc., of the island and on the faunistic changes due to man. In (**:01**) Verrill also published a paper dealing with the fauna; this contains a short article on the fishes. The birds and several groups of invertebrates have been treated in a volume by Jones and Goode (**'84**). An interesting popular account of the fish markets of Bermuda was published by Goode (**'76**^{b}) in "Forest and Stream." Günther (**'79**) has listed the species of fishes taken by the naturalists of H. M. S. Challenger near the islands.

In the present paper the notes on distribution are obtained partly from "The Fishes of North and Middle America," by Jordan and Everman, which I have found very valuable in this connection, and partly from specimens in the vast collections of the Museum of Comparative Zoölogy.

LEPTOCARDII.

BRANCHIOSTOMATIDAE.

Branchiostoma caribbaeum SUNDEVAL. **The West Indian Lancelet.**

Verrill, **:01**, p. 55.
Goode, **'77**, p. 293 (*B. lubricum*).

Distribution. — Atlantic coast of North America to Rio Plata.

Found in all localities where the bottom is suitable. Very common on the sandy spit in Flatts Inlet, directly opposite the Hotel Frascati.

Asymmetron lucayanum ANDREWS. **Andrews's Lancelet.**

Mark, **:04**, p. 179.

Distribution. — Bahamas and Bermudas.

Taken in dredgings at a number of localities in different parts of the Bermudas.

PLAGIOSTOMI.

GALEIDAE.

Carcharhinus platyodon (Poey). **Puppy Shark.**

Verrill, :01, p. 55.

Distribution. — Coasts of Texas and Cuba.

Very common off the Challenger Banks and outside the reefs. Considered a fine food fish by the colored people. The only specimen preserved was identified by Mr. Garman as belonging to this species.

TELEOSTEI.

ANGUILLIDAE.

Anguilla chrisypa Raf. Eel.

A. bostoniensis (Le Sueur) Ayres. Goode, '76^a, p. 71.

Distribution. — Atlantic coast (ascending rivers); West Indies.

Said to be common in ditches in Devonshire Marshes. The specimens, seven in number, were all obtained in mud-holes near the mangrove swamp at Hungry Bay. I found four there in April, 1903, and three in July, 1903. The largest specimen was about 4 inches in length. The only water connection of this swamp was directly with the ocean, and as no eels have ever been taken off the shores of Bermuda, it puzzles me to know how such young eels got into the mangrove swamp. The Devonshire Marshes, so far as I could learn, have no connection with the ocean; the water there is only slightly brackish.

MURAENIDAE.

Lycodontis moringa (Cuv.) Spotted Moray.

Gymnothorax moringa (Cuv.) Goode. Goode, '76^a, p. 72.

Distribution. — West Indies; North coast of South America; St. Helena.

This species with the larger *L. funebris* (Ranzani) was quite common about all the reefs, particularly off the south shore, where many are taken by fishing from the rocks. The specimen before me was taken during the "Challenger Bank Expedition" — a three-days trip provided by Captain Meyer, of St. George's, for the members of the Biological Station about the first of August, 1903. The flesh is eaten by the negroes, who say that it is sugary-sweet, and very tender; I heard nothing of its being considered poisonous.

L. sanctae-helenae (Günther).

Distribution. — Tropical Atlantic; St. Helena.

A single example taken in 1904; compared with the preceding this species is rather rare.

OPHICHTHYIDAE.

Sphagebranchus anguiformis (Peters).

Distribution. — West Indian region.

A single example of this rare species was dredged in shallow water by Professor Mark on Aug. 6., 1904, at Station No. 468. It is without spots and is 5½ inches long. The head is contained 18 times in the length of the body. A second specimen of this species, which I may mention in this connection, was dredged by Messrs. G. M. Allen, Owen Bryant and myself while on our Northern Bahama Expedition in July, 1904. It is far larger, being of the same proportions and 12½ inches long. It was dredged in 14 fms. in Whale Cay Channel off the Island of Abaco, Bahamas.

ALBULIDAE.

Albula vulpes (Linné). Bone fish.

Distribution. — Tropical seas, almost universally distributed.

D. 15; A. 8.

The species is rare at Bermuda; I have examined only a single specimen taken there. (M. C. Z. No. 18,088.)

CLUPEIDAE.

Sardinella anchovia Cuv. & Val. Anchovy.

Goode, '76ª, p. 69.

Distribution. — West Indies, N. Coast of South America.

D. 16; A. 16.

Large schools of this clupeoid were seined regularly in Hamilton Harbor and Flatts Inlet for bait. They appeared to run up into shoal water at about sunrise or sundown.

S. macrophthalma (Ranzani). Pilchard.

Harengula macrophthalma (Ranzani). Goode, '76ª, p. 69.

Distribution. — West Indies, coast of Brazil.

D. 17; A. 18. Sc. 40; 12.

We took only two specimens of this species. Mr. H. B. Bigelow and myself each took one about 11 o'clock one very warm evening in August in Flatts Inlet on a hook baited with strips of *Bathystoma.* A dark lantern turned toward the water showed a considerable number of what appeared to be the same species swimming about; no more were seen afterward. They are said to be rather common in winter.

Opisthonema oglinum (Le Sueur). Herring.

O. thrissa (L.) Goode, '76ª, p. 69.

Distribution. — West Indies, common on coasts of Florida, Georgia, and the Carolinas, occasionally much farther northward.

D. 19; A. 24.

I have about 100 specimens of this common tropical herring, varying in size from one to five inches. They appeared erratically in great schools.

ENGRAULIDAE.

Stolephorus choerostomus (Goode). Hog-mouth Fry.

Engraulis choerostomus Goode. Goode, '74, p. 380; and '76ᵃ, p. 70.
Jordan & Evermann, '96–00, vol. 1 (1896), p. 444.

Distribution. — Bermuda and Porto Rico.

D. 13 or 14; A. 23.

This species was not at all common during July, but in August immense quantities were seined for bait in Bailey's Bay and Flatts Inlet.

SYNODONTIDAE.

Synodus saurus (Linné). Snake fish.

S. lacerta (Valenciennes) Goode. Goode, '76ᵃ, p. 68.
Jordan & Evermann, '96–00, vol. 1 (1896), p. 537.

Distribution. — Atlantic coast of Southern Europe; Bermuda.

D. 12; A. 12.

One of the two specimens taken jumped into a rowboat at Flatts Inlet; they frequently rise three feet from the water in the upward dash after their prey. The second specimen was taken from the fish pot of a Portuguese at Cooper's Island by Messrs. Nichols and Bryant.

We had many opportunities to watch their habits as they lay on the white shell and coral sand in the Flatts Inlet. They changed color remarkably and mimicked their surroundings very closely indeed. They would wait until their food, usually a small fish, was directly over them, and then rise with great speed, and seize it from below.

ESOCIDAE.

Tylosurus raphidoma (Ranzani).

Distribution. — West Indies; coasts of Florida and Brazil.

D. 23; A. 22.

This species has not, I believe, been found at Bermuda before. One small specimen (4½″ lg.) was taken with a fine seine in Flatts Inlet. It showed none of the silvery coloring of the adults, but was covered with stellate chromatophores.

T. acus (Lacépède). Hound.

Distribution. — West Indies, occasionally northward and in the Mediterranean Sea.

D. 23; A. 21.

This species was present in great numbers in most of the inlets and bays about the islands. We obtained a number of specimens on hooks baited with *Sardinella* or *Stolephorus*. These fishes play havoc with the useful bait fishes, killing numbers which they do not eat. They all contained parasitic worms in the trunk musculature.

HEMIRAMPHIDAE.

Hyporhamphus unifasciatus (RANZANI). Needle fish, Gar fish.

Distribution. — Southern Florida, Panama, and Brazil.

D. 12; A. 15.

Specimens were taken with seine at low tide in the Flatts Inlet. They were quite common, but did not appear as regularly or in as large numbers as did *Tylosurus acus*.

Hemiramphus brasiliensis (LINNÉ).

H. pleii (Cuv. & Val.) Goode. Goode, '76^a, p. 64.

Distribution. — The West Indian region.

D. 14; A. 12.

One badly damaged specimen, apparently of this species, is in the collection of the M. C. Z. No. 8,774, taken by Captain Hamilton at Bermuda about 1870.

EXOCOETIDAE.

Exonautes esiliens (MÜLLER). Flying fish.

Exocoetus exiliens Gmelin. Goode, '76^a, p. 64.

Distribution. — Pelagic.

D. 12–13; A. 12; P. 18; V. 6; C. 21.

One young specimen of what appears to be this species was taken from *Sargassum* off the Challenger Banks and thirteen young examples were taken in the tow net, July 7, at 9 p. m., wind east, in Flatts Inlet. No adult flying-fishes were seen close to shore at any time, and only very few inside the outer reefs. Hundreds of flying fishes, however, were seen from the steamer from forty to sixty miles off shore.

FISTULARIIDAE.

Fistularia tabacaria LINNÉ.

Goode, '76^a, p. 27.
Fistularia serrata Goode, '76^a, p. 75.

Distribution. — West Indies, straying northward.

D. 14; A. 13.

One specimen of this curious species was taken by Mr. L. Mowbray off St. George's and was kindly obtained from him by Prof. E. L. Mark for examination.

SYNGNATHIDAE.

Siphostoma jonesi (GÜNTHER).

Jordan & Evermann, '96–00, vol. 1 (1896), p. 768.
Syngnathus jonesi Günther, '74, p. 455. Goode, '76^a, p. 27.

Distribution. — Bermuda and Porto Rico.

Mr. O. Bryant obtained a single specimen of this species under a rock at Hungry Bay; and a second specimen has recently been handed me by Professor Mark; it was taken during July, 1904.

S. pelagicum (OSBECK).

Syngnathus pelagicus Osbeck. Goode, 76^a, p. 27.

Distribution. — Tropical Atlantic and Mediterranean.

About a dozen specimens were obtained in *Sargassum* and by the dredge in from 6–12 fm. Several very large specimens were taken during July, 1904.

S. mackayi SWAIN & MEEK.

Distribution. — S. Florida to Yucatan.

One small specimen was taken from the dredge in Castle Harbor. This is the first time the species has been reported from Bermuda.

S. dendriticum, sp. nov.

(Plate 1.)

Type, (M. C. Z. No. 29,057) a single specimen dredged in about 7 fms. off Ireland Island, Bermudas, July, 1904.

Rings 14 + 39. Dorsal 16, just over vent on rings 1–4.

Snout about twice in distance to base of pectoral. Tail longer than body. Anal fin vestigial; composed of two rays on ring 2. Color brown with irregular blotches and darker marblings. A number of peculiar filamentous appendages; many of these have probably been torn off, as this specimen was taken in the dredge with a considerable mass of broken *Oculina*, etc. The largest pair of these appendages is situated just above and behind the orbits. The next largest pair is on the nape, just anterior to the branchial aperture. Pairs of filaments are situated irregularly along the dorsal and ventral surfaces. On the segments of the trunk rings are peculiar radiating striae; and a raised boss marks the centre of each segment. On the tail rings the bosses are very conspicuous and the ornamental striae less so.

HIPPOCAMPIDAE.

Hippocampus sp. Sea Horse.

One exceedingly small specimen taken in the tow-net off Flatts Inlet one night during July. I have been unable to determine the species. Sea-horses are well known to the natives, and are said to be common at certains seasons.

ATHERINIDAE.

Menidia notata (Mitchill).

Distribution. — Coast of United States southward to the Carolinas.

D. 6+9; A. 1, 23.

There is one specimen of this species in the collection of the M. C. Z. (No. 18,246); so far as I can ascertain no other specimen has ever been taken.

M. menidia (Linné). Blue Fry.

Distribution. — Atlantic coast of United States, the Carolinas southward.

D. 4+9; A. 1+22.

This species was exceedingly common in Flatts Inlet. Thousands were seined daily by the natives for bait.

MUGILIDAE.

Mugil brasiliensis Agassiz. Mullet.

M. liza Cuv. & Val. Goode, '76^a, p. 63.

Distribution. — West Indies; Atlantic coast of South America.

D. 5+8; A. 3+8.

Specimens were frequently taken from the seine in Flatts Inlet; the species is generally common.

M. curema Cuv. & Val.

Distribution. — Both coasts of the Americas.

D. 5+5; A. 3+9.

I obtained a large number of specimens of this species in March and April, 1903, at Hungry Bay. During the summer, however, only one specimen was taken; this was from *Sargassum* floating off Ireland Island. The species has not been taken before at Bermuda.

SPHYRAENIDAE.

Sphyraena sphyraena (Linné.)

S. spet (Haüy) Goode, '76^a, p. 61.
Jordan & Evermann, '96–00, vol. 1 (1896), p. 826.

Distribution. — Southern coast of Europe to Bermuda.

D. 6+9; A. 1+9.

This European species is not uncommon about Bermuda. I have a single specimen about 10 inches long taken in the seine near Gibbet Island and another, considerably smaller, taken by the members of the Biological Station during the summer of 1904.

HOLOCENTRIDAE.

Holocentrus ascensionis (Osbeck). Squirrel.

Holocentrum sogo Bloch. Goode, '76ᵃ, p. 49.

Distribution. — Florida and Cuba to St. Helena.

D. 11 + 15 ; A. 6 + 10.

This species is very common in sheltered nooks about the rocky shores and reefs. It is nocturnal and great numbers were sometimes taken in a few hours at night in the fish pots.

H. puncticulatus, sp. nov.

(Plate 2.)

D. 11 + 13 ; A. 4 + 8 ; ll. 45 ; ltr. 3 + 8.

Near *H. siccifer* Cope, but differing in the number of rays in the anal fin, in the shape of the dorsal fins, and in color.

Head with spines 2½, depth 2¾. Spinous dorsal rather long and elevated anteriorly ; soft dorsal not as high as spinous portion. Second anal spine and first anal soft ray about the same length and almost reaching the base of the caudal. There is one strong spine on the preopercular bone and one on the opercular. The posterior and ventral edges of both these bones are strongly serrate. The interorbital keels are rather weak, and each divides posteriorly into nine, spreading out in a fan-like manner.

The color in life is bright rosy red with nine lateral series of very fine black and dark brown dots ; growing fainter and fewer ventrally. A large black spot appears on the membrane of the first three dorsal spines, and also on the spines themselves. The rest of the fins are rosy white, except for a few extremely faint dusky patches on the posterior part of the first dorsal.

This species is represented by the single type specimen (M. C. Z. No. 29,054), Flatts Inlet, Bermuda Is. Taken in a fish trap in about 10 ft. of water. The species is rather common, and other specimens were seen.

MULLIDAE.

Upeneus maculatus (Bloch). Goat fish.

Hypeneus maculatus (Bloch) Cuv. Goode, '76ᵃ, p. 49.

Distribution. — West Indian region.

D. 8 + 8 ; A. 2 + 6.

Probably common in rather deep water outside the reef. One specimen was taken in a fish pot off Hungry Bay by a fisherman, who said that the species was not uncommon, and another from the stomach of a large grouper (*Epinephelus striatus*).

CARANGIDAE.

Decapterus punctatus (Agassiz). Robin.

Goode, '76, p. 46.

Distribution. — Mass. to Brazil.

D. 3 + 30 (31); D. 3 + 25. Sc. 40 about.

I have four specimens, two taken by Dr. A. S. Bickmore (M. C. Z. No. 17,054), and two taken in Harrington Sound in July, 1903. This species is common at times, but it is at other times quite impossible to find a single specimen. They take bait best at night in moderately deep water.

Seriola zonata (Mitchill). Crevalle.

Goode, '76^a, p. 75.

Distribution. — Massachusetts to the Carolinas.

D. 8 + 38; A. 3 + 21.

One specimen taken on the Challenger Banks. I saw quite a number of these brought in by the Hamilton fishermen. They were usually taken far off shore.

Trachurops crumenophthalmus (Bloch). Goggle-eye.

Goode, '76^a p. 47.

Distribution. — Coast of Atlantic Ocean (except Europe). Pacific off Central America and Mexico.

D. 8 + 26; A. 3 + 22. Sc. 36.

One specimen about two inches long was taken from *Sargassum* off the Challenger Banks and turned over to me by Professor Mark. The species was very rare at Bermuda all summer. A slightly smaller specimen was taken during July, 1904.

Caranx ruber (Bloch).

Distribution. — West Indies.

D. 8 + 27; A. 2 + 23. Sc. 30.

One specimen taken in the tide rush at mouth of Harrington Sound on hook baited with *Stolephorus*. A second specimen (M. C. Z. 17,360) was taken at Bermuda in 1864 by Capt. Hamilton. This specimen has 31 scutes on the caudal pedicel.

C. hippos (Linné).

Distribution. — Tropical seas.

D. 8 + 21; A. 2 + 17. Sc. 30.

One specimen taken on hook and line in Flatts Inlet in about four feet of water and two specimens from Hamilton (M. C. Z. No. 28,989) are the only representatives of this widely distributed species which I have had an opportunity to examine from Bermuda.

C. crysos (MITCHILL). Jack.

Goode, **76**^{a}, p. 75.
Paratractus pisquetus (C. & V.) Gill. Goode, **76**^{a}, p. 47.

Distribution. — Massachusetts to Brazil.

D. 8 + 25 ; A. 2 + 21. Sc. 45.

I have examined four specimens of this species from Bermuda; three were taken in the summer of 1903 at Flatts Inlet, the other at Hamilton about 1870 (M. C. Z. No. 17338). A number of these fishes were almost always to be found lying in wait for fry carried out of Harrington Sound by the tide. They took bait voraciously and afforded considerable sport for their size. We took none over 9 inches in length. The name Jack is applied to several species.

NOMEIDAE.

Nomeus gronovii (GMELIN).

Jordan & Evermann, **'96-00**, vol. 1 (1896), p. 949.

Distribution. — Tropical Atlantic.

D. 11 + 26 ; A. 3 + 26.

This species appears to be rather common in Castle Harbor, where the only specimens seen were taken. They usually swim about among the tentacles of the Portuguese-man-o-war, but the only specimen I caught was swimming lazily along near the surface of the water ; there were, however, plenty of *Physaliae* near by.

CORYPHAENIDAE.

Coryphaena equisetis (LINNÉ). Dolphin.

Distribution. — Open Atlantic, most common in the tropics.

D. 52 ; A. 25.

A single specimen taken off Bermuda during the summer of 1904. It was said to be very common at all times at some distance off shore.

CHEILODIPTERIDAE.

Apogon binotata (POEY).

Distribution. — Florida, West Indies, and Brazil.

D. 7 + 8; A. 2 + 8.

A single specimen of this species was taken in Castle Harbor, it appears to be rare. Several natives to whom I showed the specimen declared that they had never seen it before. I compared it with Poey's type from Cuba (M. C. Z. No. 8,750) and could find no difference between them.

A. maculata (POEY).

Distribution. — Cuba.

D. 4 + 10; A. 2 + 7; ll. 27, ltr. 2 + 10.

I have five specimens of this handsome species. Three of these were taken in Flatts Inlet; I took one in July, 1903, and Mr. Nichols two in August. The remaining two came from some floating *Sargassum*; one on the Challenger Banks, the other near the main island; both specimens are very small. I was told that the species became very common in Flatts Inlet about the latter half of August.

SERRANIDAE.

Bodianus fulvus (Linné). Nigger fish..

Jordan & Evermann, '96–00, vol. 1 (1896), p. 1144.

Distribution.—West Indies.

This species appears to be very generally distributed over the reefs, and moderately common everywhere.

Epinephelus striatus (Bloch). Grouper, Hamlet.

Goode, '76ª, p. 57.

Distribution. — West Indies to Brazil.

D. 9 + 17; A. 3 + 8.

The most important food fish taken near Bermuda. My specimens are small ones taken in fish pots near Flatts Inlet. It attains a weight of 40 pounds.

E. maculosus (Cuv. & Val.). Hind.

Jordan & Evermann, '96–00, vol. 1 (1896), p. 1158.
E. gutattus (Gmelin) Goode. Goode, '76ª p. 58.

Distribution. — The West Indies generally.

D. 9 + 16; A. 3 + 8.

This species was very common everywhere about the reefs. We took specimens by the hook up to 15 or 16 inches in length near North Rock, where they were especially common. Their power of changing color is highly developed; for they change from almost uniform ruddy to flaming red spotted regularly with deep brown or black.

E. morio (Cuv. & Val.). Red Hamlet.

Distribution. — Southern Atlantic coast of North America southward to Brazil.

D. 9 + 16; A. 3 + 9.

This species was generally taken with *E. striatus*, but was far more rare than that species. It is said to be growing more common year by year.

Mycteroperca venenosa apua (Bloch). Rock-fish.

Trisotropis undulosus (Cuv.) Gill. Goode, '76ª, p. 55.

Distribution. — West Indies, Florida Keys to Brazil.

Grows to a great size and is one of the most important of the common food fishes.

Hypoplectrus puella Cuv. & Val. Mutton Hamlet.

Goode, '76^a, p. 60.

Distribution. — West Indies.

D. 10 + 14; A. 3 + 7.

Not uncommon about rocky shores with very steep banks; but locally distributed. Six specimens were taken in fish pots in Harrington Sound near the bridge and off the dock of the Hotel Frascati.

Paranthias furcifer (Cuv. & Val.). Barber.

Distribution. — Both coasts of Tropical America.

D. 9 + 18; A. 3 + 9.

This species has not been previously recorded from Bermuda. Mr. J. T. Nichols took three specimens, each about 1 foot long, off the south shore near Hungry Bay with hook and line. Two were also among the collection made in July, 1904. The color of all was a dull uniform rose pink.

LUTIANIDAE.

Neomaenis griseus (Linné). Gray snapper.

Lutjanus caxis (Schn.) Poey. Goode, '76^a, p. 54.

Distribution. — West Indies, South Atlantic coast of United States to Brazil.

D. 10 + 14; A. 3 + 8; ll. 51; ltr. 7 + 13.

One of the most common Bermudian fishes; large schools could be seen swimming about in Harrington Sound or Flatts Inlet at any time. About 50 of them spent most of their time under our boat at her moorings, never seemed to be more than a few yards from this location. They are shy and extremely difficult to take. The specimens before me are from Harrington Sound. They appear less shy in Hamilton Harbor, where many are taken on hooks and in fish pots for bait.

N. apodus (Walbaum). Schoolmaster.

Distribution.—West Indies; Florida to Brazil.

D. 10 + 14; A. 3 + 8.

Several specimens taken from both Hungry Bay and Harrington Sound. The young were common in many small coves along this shore, and large specimens are often taken about the outer reefs.

N. vivanus (Cuv. & Val.). Silk snapper.

Distribution. — West Indies.

D. 10 + 14; A. 3 + 8.

A very common species in the deeper water about the outer reefs and in the middle of Harrington Sound. I have several specimens taken with a fish pot in the steamboat channel about opposite Bailey's Bay. This species takes bait well, especially at night, and affords fair sport.

N. hastingsi Bean. Spot snapper.

Bean, '98, p. 45.

Distribution. — The Bermudas.

D. 10 + 14; A. 3 + 8.

One specimen of this species was turned over to me by Prof. E. L. Mark; it was taken on the Challenger Banks. Dr. Bean states that this is the "silk snapper" of the native fishermen; but so far as I could ascertain from numerous inquiries, that name is only used for *N. vivanus* (C. & V.).

Ocyurus chrysurus (Bloch). Yellow tail.

Goode, '76ª, p. 55.

Distribution. — West Indies to Brazil.

D. 10 + 13; A. 3 + 9; ll. 66; ltr. 7 + 16.

This species was very common in Harrington Sound, where large numbers were sometimes taken using "scuttle" (*Octopus rugosus*) for bait. My specimens are from fish pots in Flatts Inlet and Harrington Sound. The species attains a weight of 5 lbs.

HAEMULIDAE.

Haemulon macrostomum Günther. Sow grunt.

Distribution.—West Indies generally.

D. 12 + 16; S. 3 + 8.

This species was frequently brought into Hamilton by the fishermen, who took it in rather deep water near the outer reefs, usually in company with *Haemulon album.*

H. carbonarium Poey. Bull grunt.

Jordan & Evermann, '96-00, vol. 2 (1898), p. 1300.

Distribution. — West Indies.

D. 12 + 16; A. 3 + 8.

This fish was not at all uncommon off the South shore; it was rarely taken anywhere else. We have several specimens from about one mile south of the mouth of Hungry Bay.

H. sciurus (Shaw). Striped grunt.

Distribution. — West Indies generally.

This fish was taken occasionally in fish pots off the South shore and in Hamilton Harbor. It did not appear to be nearly as common as *H. flavolineatum.* There are two specimens (M. C. Z. No. 10,555) which were taken in 1862 by Dr. Bickmore.

H. flavolineatum (Desmarest). Yellow grunt.

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1306.

Distribution. — West Indies.

This species is very common everywhere about Bermuda. There are thirty-four specimens in the Museum which were taken by Dr. A. S. Bickmore in September, 1862 (M. C. Z. Nos. 10,526, 10,541). It does not usually grow to a size suitable for food. A large number were taken during August, 1903, in Harrington Sound.

Orthopristis chrysopterus (Linné). Sailor's choice.

Distribution. — Atlantic and Gulf coasts of the United States.

D. 13 + 16; A. 3 + 12.

This species was quite common in Hamilton Harbor, though I never saw a single example elsewhere in the Bermudas.

Bathystoma striatum (Linné).

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1310.

Distribution. — Bermudas to South America.

D. 13 + 13; A. + 37.

Common, particularly in Flatts Inlet, where it may be taken any day usually associated with very large numbers of *B. rimator.* There are twenty specimens (M. C. Z. No. 10,602) which were taken by Dr. Bickmore in 1862.

B. rimator (Jordan & Swain). White grunt.

Distribution. — East coast of United States and West Indies.

D. 13 + 15; A. 3 + 8.

An excessively common species in Flatts Inlet, less so elsewhere. I have specimens taken in a fish trap in Harrington Sound and Flatts Inlet; any number could have been collected.

SPARIDAE.

Calamus calamus (Cuv. & Val.). Porgy.

C. megacephalus (Swainson) Poey. Goode, '76ᵃ, p. 51.
C. orbitarius Poey. Goode, '76ᵃ, p. 51.

Distribution. — West Indies and Florida.

D. 12 + 12; A. 3 + 10.

The fishermen recognize two "Porgies": the "Goat head," and the "Sheep head." I think, however, that both species are referable to *C. calamus*, for they did not seem to be very certain as to just what constituted a "Goat head" or "Sheep head" porgy.

Diplodus sargus (Linné). Bream.

Jordan & Evermann, '96–00, vol. 2 (1898), 1363.
Sargus variegatus (Lacépède), Goode. Goode, '76ª, p. 52.

Distribution. — Coast of Southern Europe, westward to Bermuda.

D. 12 + 13 (14); A. 3 + 13 (14).

One of the commonest shoal water species. It was strangely confused with *Kyphosus sectatrix* by Goode.

GERRIDAE.

Eucinostomus gula (Cuv. & Val.). Shad.

Goode, '76ª, p. 39.

Distribution. — New York (rarely) to Brazil.

D. 9 + 10; A. 3 + 8.

Common, generally associated in small schools with the young of *Neomaenis griseus* and *Mugil brasiliensis.*

KYPHOSIDAE.

Kyphosus sectatrix (Linné). Chub.

Pimelepterus boscii (Lacépède). Goode, '76 , p. 52.

Distribution. — Pelagic in North Atlantic; West Indies.

D. 11 + 12; A. 3 + 11.

This species may be called an irregular, though usually very common, visitor at Bermuda.

POMACENTRIDAE.

Abudefduf saxatilis (Linné). Cow pilot. Sergeant major.

Glyphidodon saxatilis (Linné) Cuvier. Goode, '76ª, p. 38.

Distribution. — Both coasts of Tropical America.

D. 8 + 13; A. 2 + 12; ll. 28; ltr. 11 + 5.

I have about twenty specimens of this species varying in length from a half inch to four inches, the latter being a large one for the shores of Bermuda. I saw a very large specimen in a rock pool at North Rock. Native fishermen state that the species attains a weight of one and one half pounds in the deep water off the Rock. It is very common everywhere.

Furcaria cyanea Poey.

Distribution. — Cuba.

D. 12 + 12; S. 2 + 12.

A single specimen from Bermuda taken in 1864 by Captain Hamilton (M. C. Z. No. 14,801). I can find no other record for the occurrence of this species except off Cuba.

Microspathodon chrysurus (Cuv. & Val.).

Distribution. — West Indies.

Two very small specimens from *Sargassum* off Ireland Island. The species does not appear in previous lists, so far as I am aware.

Eupomacentrus leucostictus (Müller & Troschel). Cock-eye pilot.

Distribution. — West Indies; Florida.

D. 12 + 15; A. 2 + 13.

Although with considerable hesitation, I refer to this species a number of Pomacentroids which were taken in various localities, about the Islands. The genus is in a very confused condition, and I have no desire to describe these specimens as new until a more extensive examination of existing material can be made.

E. fuscus (Cuv. & Val.). Brown cock-eye pilot.

Verrill, :01, p. 56.

Distribution. — Florida to Brazil; West Indies.

Specimens which may be this species are very common in many localities especially at the head of Hungry Bay, both among the loose rocks of the Spit and among the roots of the mangroves.

LABRIDAE.

Lachnolaimus maximus (Walbaum). Hog fish.

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1579.
L. falatus (L.). Goode, '76ᵃ, p. 36.

Distribution. — West Indies.

D. 14 + 11; A. 3 + 10.

An important and common food fish, growing to the size of about twenty pounds.

Iridio radiatus (Linné). Lady fish. Blue fish.

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1590.
Choerojulis radiatus (L.) Goode. Goode, '76ᵃ, p. 35.

Distribution. — West Indies; Florida to Brazil; St. Paul's rocks.

Not uncommon a short distance off the South shore.

I. cyanocephalus (Bloch). Blue head.

Distribution. — West Indies to Brazil.

Rather rare; the few which we have were taken on the reef off the south shore. This is the most northerly record for the species.

I. garnoti (Cuv. & Val.).

Distribution. — West Indies.

One small specimen obtained in Castle Harbor. The species has not been recorded from Bermuda before.

I. bivittatus (Bloch). Slippery Dick.

Platyglossus bivittatus Bloch. Goode, '76ª, p. 75. Garman, :00, p. 510.

Distribution. — West Indies; Carolinas to Brazil.

D. 9 + 11; A. 3 + 12.

Very common everywhere.

Chlorichthys nitidissimus (Goode). Slippery Dick.

Jordan & Evermann, '96–00, vol. 2 (1898), p. 1608.

Distribution. — The Bermudas.

Rather common about the outer reefs.

SCARIDAE.

Sparisoma abildgaardi (Bloch).

Distribution. — West Indies to Brazil.

D. 9 + 10; A. 2 + 9.

This and the three following species are all called Parrot fishes. I have a single specimen of this species taken in a fish pot off the south shore. It does not appear to have been recorded from so far north before.

S. viride (Bonnaterre).

Distribution. — West Indies.

D. 9 + 10; A. 2 + 9.

A single specimen, which was taken with the preceding species, is the only one we obtained. The natives consider it very rare.

Scarus croicensis (Bloch).

Pseudoscarus sanctae-crucis Günther. Goode, '76ª, p. 75.

Distribution. — West Indies generally.

D. 9 + 10; A. 2 + 9.

Not uncommon in Castle Harbor and occasional in Flatts Inlet. There are several specimens taken from both localities in the collection made in the summer of 1903.

S. caeruleus (Bloch).

Pseudoscarus caeruleus (Bloch) Günther. Goode, '76ª, p. 33.
P. psittacus Goode, '76, p. 75.

Distribution. — West Indies, on our coast, rare.

D. 9 + 10; A. 2 + 9.

Not uncommon.

CHAETODONTIDAE.

Chaetodon ocellatus (Bloch). Butterfly fish.

Distribution. — Cuba; Gulf Stream northward.

Rather rare about the outer reefs; but said by the fishermen to be increasing rapidly in numbers.

C. capistratus (Linné). Four eyes.

Goode, '76ª, p. 75.

Sarothrodus bimaculatus (Bloch) Poey. Goode, '76ª, p. 43.

Distribution. — West Indies.

D. 12 + 19; A. 3 + 17.

Common in many localities about Hamilton Harbor, Harrington Sound, and Castle Harbor.

Angelichthys ciliaris (Linné). Angel fish.

Holacanthus ciliaris (Linné) Lacépède. Goode, '76ª, p. 43.

Distribution. — West Indies and Florida.

D. 14 + 21; A. 3 + 21.

An important food fish, very common about the reefs and steep shores. For some reason the specimens taken off the north shore are considered much more palatable than those taken off the south shore.

TEUTHIDIDAE.

Teuthis hepatus (Linné). Blue tang.

Acanthurus chirurgus (Bloch.) Schn. Goode, 76ª, p. 42.

Distribution. — The West Indian region.

D. 9 + 24; A. 3 + 22.

A few specimens were obtained, but the species did not appear to be as common as the following, with which it was almost always associated.

T. bahianus (Castelnau). Doctor fish.

Distribution. — West Indies; both coasts of Tropical America.

D. 9 + 25; A. 3 + 23.

Decidedly abundant about the reefs and steep shores. Though the adults did not run up into Flatts Inlet, the young were frequently seen there.

T. helioides, sp. nov. Yellow doctor.

(Plate 3.)

D. 9 + 26; A. 3 + 26.

Most nearly related to *T. chrysosoma* (Bleeker) from the Sea of Kajeli. Form ovate; height of body rather more than one half of total length (caudal fin included). The profile of the snout is slightly concave. There are five incisors on each side of the upper jaw. The upper lobe of the caudal fin is slightly longer than the lower. The scales of the body are very minute. In life the color was brillant yellow, which has changed in spirits to a dull lustreless yellow. The dorsal, anal, and ventral fins are edged with dusky brown, almost black in some places. There is a diffuse patch of light brown on the operculum.

Type (M. C. Z. No. 29,053) a single specimen five inches long taken near Cooper's Island, in Castle Sound, Bermudas, by Messrs. O. Bryant and J. T. Nichols.

BALISTIDAE.

Balistes carolinensis Gmelin. Turbot.

B. capriscus Gmelin. Goode, '76ª, p. 25.

Distribution. — Tropical Atlantic, Mediterranean Sea.

D. 3 + 27; A. 25.

We took several specimens in fish pots in about five fathoms off Flatts Inlet, and I have also one very small one from *Sargassum* of the Challenger Banks given me by Mr. J. T. Nichols. The species grows to considerable size and is frequently eaten, although the flesh is dry and tasteless.

B. vetula Linné. Queen turbot.

Goode, '76ª, p. 26.

Distribution. — West Indian region generally.

D. 3 + 29; A. 27.

Not taken by Goode, but nevertheless rather common. A regular visitant at Bermuda, as several are taken every year. The specimen before me was brought into the Biological Station during the summer of 1904.

MONACANTHIDAE.

Alutera scripta (Osbeck).

Goode, '76ª, p. 26.

Distribution. — Tropical seas of both hemispheres.

D. 1 + 47; A. 51.

A single specimen of this species was speared at Bermuda during the summer of 1904 and obtained by Professor Mark.

TETRAODONTIDAE.

Spheroides spengleri (Bloch). Puffer.

Chilichthys spengleri (Bloch).
Goode, '76ª, p. 22.

Distribution. — Eastern Atlantic.

D. 7; A. 6.

One specimen from Hungry Bay, two inches long, taken by Mr. Nichols and one specimen from the dredge, one inch long, among the reefs off Ireland Island in 8–10 fms. This species did not appear to be at all common and no adults were seen. While collecting invertebrates Mr. Bigelow and I both saw several large "puffers" which appeared to be *S. testudineus*, and I have no doubt that this species will occur in future collections.

SCORPAENIDAE.

Scorpaena agassizii GOODE & BEAN.

Goode & Bean, '**96**, p. 247.

Distribution. — West Indian region.

One specimen dredged on the Challenger Bank, by the members of the Biological Station, in forty fathoms.

CEPHALACANTHIDAE.

Cephalacanthus volitans (LINNÉ).

Distribution.—Tropical Atlantic, widely distributed.

D. 2 + 4 + 8; A. 6.

One specimen was taken on the beach at Gibbet Island on June 19, 1903. The species is very rare at Bermuda, and was not known to any of the fishermen that saw the specimen. I learned, however, from Mr. F. Goodwin Gosling, Secy. of the Bermuda Natural History Society, that one specimen had been taken during the spring in Hamilton Harbor.

CALLIONYMIDAE.

Callionymus bermudarum, sp. nov.

D. 3 + 7 ; A. 4.

Most nearly related to *C. pauciradiatus* Gill; but differing in the number of rays in the second dorsal and in the preopercular spine. Besides giving the radial formula for his specimen (D. 3, 6; A. 3), Gill ('**65**, p. 144) says : —

"The preopercular spine is armed with three teeth above and terminates behind in an acute point."

A description of the three specimens from Bermuda follows : —

Head (to tip of opercular spine) 3½ times in total length ; depth 8 times. Ventral surface of body flat ; without a bordering fold of skin ; a single lateral line ; diameter of eye a little less than length of snout. The maxillary reaches about ⅓ the distance to the eye. The preopercular spine is armed with two barbs directed forward and situated dorsally ; there is also a sharp termination to the spine itself, which is directed straight backward. The gill opening is a very minute slit, also directed backward. In one specimen the first dorsal ray reaches the base of the caudal ; each of the other two being successively a little shorter. In the other two specimens the length of the dorsal is about equal to the distance from the posterior border of the eye to the tip of the snout. The pectoral fins are about as long as the head; the ventrals slightly shorter. The color of these specimens is a milky white, irregularly banded and blotched with light brown. In the largest one (with the filamentous dorsal) the anal fin is rather dark brown and there is a dark spot on the ventral fin and on the middle of the throat, nearly covering it.

Type series, three specimens (M. C. Z. No. 29,055) 1¼", 1", ¾", lg. from Bermuda. Taken by the dredge in from 6–8 fms.; Aug. 1903, the largest off Castle Island, the others off Ireland Island.

GOBIIDAE.

Gobius stigmaturus Goode & Bean.

Garman, :00, p. 510.

Distribution. — Bermuda.

D. 4 + 12 ; A. 12.

One specimen from Hungry Bay was taken from under a stone at low tide in about four inches of water by my brother, Mr. W. W. Barbour, April, 1903; a diligent search in the same and similar localities failed to yield a second specimen.

G. soporator Cuv. & Val. Molly miller.

Goode, '76ᵃ, p. 75.

Distribution. — The West Indian region and Northern South America.

D. 6 + 10; A. 1 + 7.

The forty-eight specimens before me show a decided differentiation into two distinct color phases. One lot, consisting of twenty-six specimens, was taken by me, with the aid of Messrs. Bigelow and Cole, in the rock pools of the south shore near Hungry Bay. All these specimens, except two, which are quite black, are very dark brown. The rest, some twenty or more, were taken by dredging in Castle Harbor and Mangrove Bay, in localities where the bottom was white sand composed of coral, shell, and Foraminifera. All these specimens are light gray, almost white, with a row of dark lateral puncticulations, just visible.

This species is very active and jumps about on the bare rocks washed by the waves and even moves from one tide pool to another over dry land.

BLENNIIDAE.

Labrisomus nuchipinnis (Quoy & Gaim.). Molly miller.

Labrosomus nuchipinnis (Quoy & Gaim.) Poey. Goode, '76ᵃ, p. 28.

Distribution. — West Indies and coast of Southern States.

D. 18 + 12; A. 2 + 17.

I collected four specimens of this species in March, 1903, all of a characteristic mottled brown color. In July, 1903, I took eight more, four of which showed the same color as those taken in the early spring. The others were gorgeously bright with yellow, red, and orange about the foreparts of their bodies. These were all males, the darker ones being females with eggs almost ready to hatch.

I had an opportunity to watch a pair of these fishes getting ready to lay. The female would move swiftly about in the sand under a protecting rock, thus scooping out a hollow place in which she probably deposited her eggs. In a few days the female, looking thinner, lay quite still near the hollow in the sand, where I presume the eggs had been laid; the male was swimming nervously about as if to drive away intruders. Up to the time I left, more than a month after the probable laying of the eggs, the male, with the same gaudy color, was still swimming about; the female was gone, and I presume the young had been hatched and had long since departed.

Salariichthys textilis (Quoy & Gaim.). Molly miller.

Salarias textilis, Quoy & Gaim. Goode, '76^a, p. 29.

Distribution. — Bermudas to Northern South America.

Very common in tide pools about the shores and at North Rock.

BROTULIDAE.

Brosmophysis verrillii Garman.

Garman, :00, p. 511.

Distribution. — Bermuda.

D. 71; A. 52; ll. 98; ltr. 25.

Several specimens of this little known Brotuloid were taken by Mr. H. B. Bigelow and myself from the rock pools near Flatts Inlet and Gibbet Island. A diligent search at Bailey's Bay, the type locality, and in many other likely places failed to reveal a single specimen.

PLEURONECTIDAE.

Platophrys lunatus (Linné). Plate fish.

Distribution. — West Indies generally.

Apparently the only flat fish which is common about Bermuda. Several were taken during my stay in the summer. The only specimen which I had an opportunity to observe carefully was one loaned to Professor Mark by Mr. L. Mowbray of St. George's.

ANTENNARIIDAE.

Pterophryne gibba (Mitchill). Mouse fish.

Distribution. — West Indies generally.

D. 3 + 12; A. 7.

Very common in the *Sargassum*. I have about sixty specimens, a few of which were taken from the dredge off Ireland Island.

P. ranina TILES.

Distribution. — Fields of sea weed in the Tropical Atlantic, Richardson.

A single large pediculate was obtained from a colored fisherman and handed to me by Professor Mark. It is evidently Cuvier's *Chironectis laevigatus* and also agrees remarkably well with Richardson's ('44–48, p. 15, pl. 9, Fig. 354), *Chironectis pictus* var. *vittatus*.

Antennarius stellifer, sp. nov.

(Plate 4.)

D. 3 + 12; A. 7; V. 5; P. 10; C. 9.

Closely related to *A. nuttingii* Garman; but differing conspicuously in coloration, size, and form of bait.

In form this species is short and extremely bulky anteriorly. The caudal peduncle is short and compressed. The head is as wide as high; with a rather deep, scaleless concavity behind the second dorsal ray. The mouth is very wide, almost vertical, and the eye is small. The first dorsal ray is extremely long and slender, a little more than 2¼ times the length of the second dorsal ray. On the posterior surface of the second dorsal ray there is a peculiar fringe of elongate scales, a tuft of similar scales being situated on each side of the naked occipital depression. The base of the first dorsal ray is a prominent movable pedicel. The second dorsal ray is quite free, while the third is connected with the dorsum by the skin. The soft dorsal is composed of two regions; the anterior five rays are of equal size and their tips do not extend beyond the connecting membrane. The condition in the posterior part of the fin is very different; the rays do project beyond the membrane, and from the sixth to eighth ray the height of the fin increases regularly, while from the ninth to twelfth the decrease is as regular, so that the posterior portion is more or less fan-shaped. The bait on the tip of the first dorsal ray is a tiny sphere, from which spring numerous delicate filaments.

The color of this species, described from the alcoholic specimen, is as follows: — The entire body is very dark brown, almost black with areas of deep velvety black, which are sometimes surrounded in a zone of lighter brown. The bait, posterior surface of second dorsal ray and under surface of the pectoral and ventral fins is dirty white. There is on each side of the body an irregularly stellate figure of white composed of a central patch and radiating spots. A white saddle is situated on the caudal peduncle.

Only one specimen known, the type (M. C. Z., No. 29,056), obtained in Castle Harbor by Mr. L. Mowbray of St. George's, and procured from him by Professor Mark.

A. scaber (CUV.)

Distribution. — West Indian waters.

A single specimen from Bermuda was obtained in exchange from the Boston Society of Natural History. It had been in the collection for some time.

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EXPLANATION OF PLATES.

PLATE 1.

Siphostoma dendriticum, sp. nov. (p. 115).
Four (4) times natural size

PLATE 2.

Holocentrus puncticulatus, sp. nov. (p. 117),
Twice natural size.

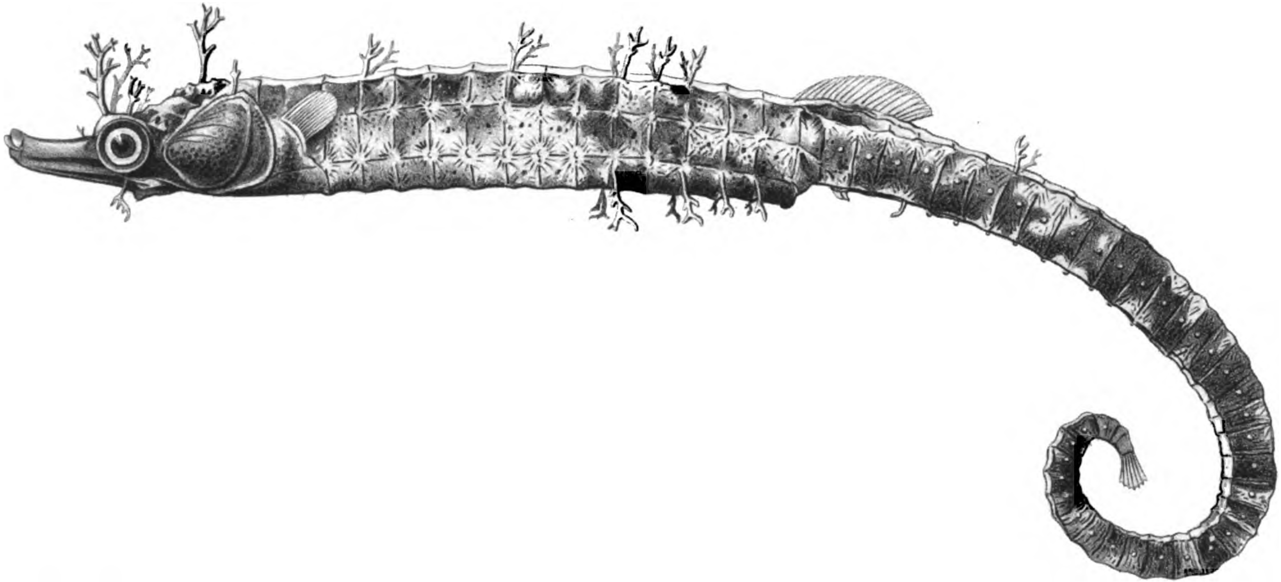
PLATE 3.

Teuthis helioides, sp. nov. (p. 127).
Natural size.

PLATE 4.

Antennarius stellifer, sp. nov. (p. 132).
Very slightly enlarged.

PLATE 1.



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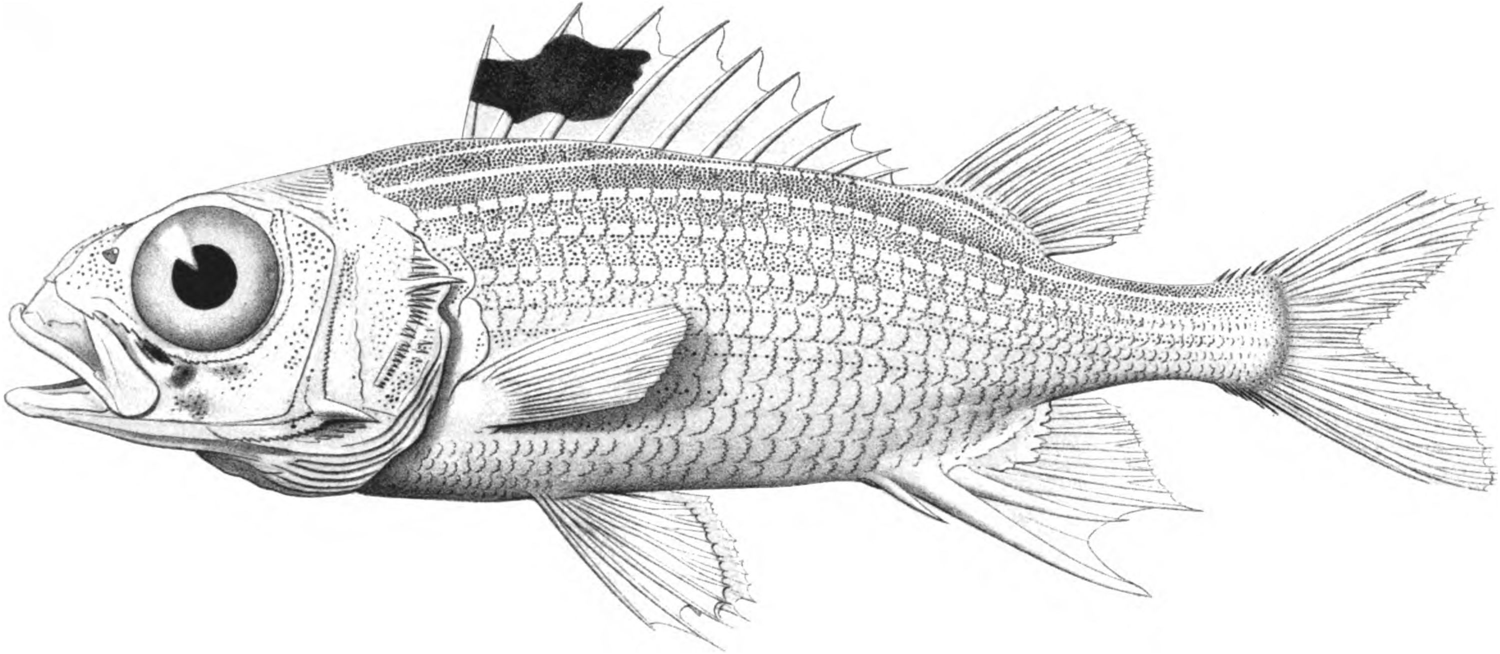
B. Meisel lith.



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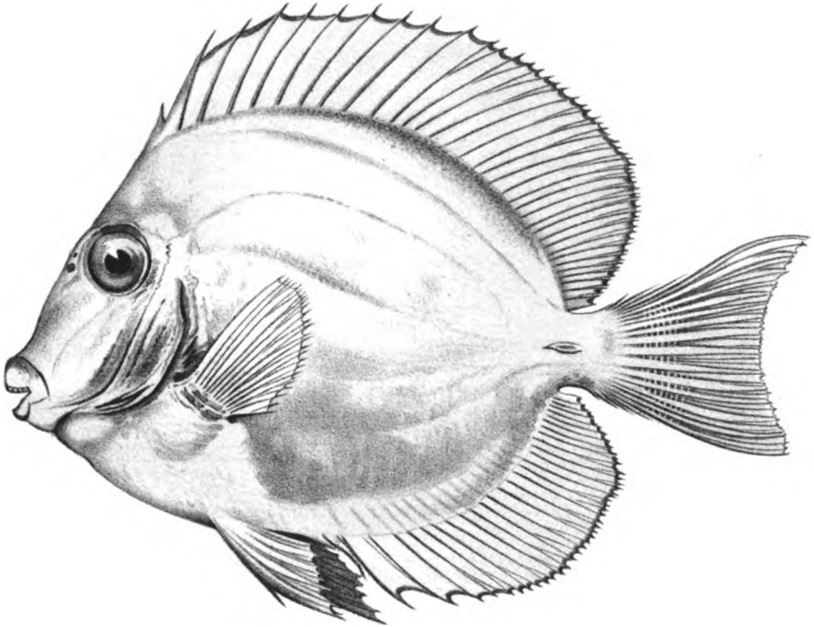

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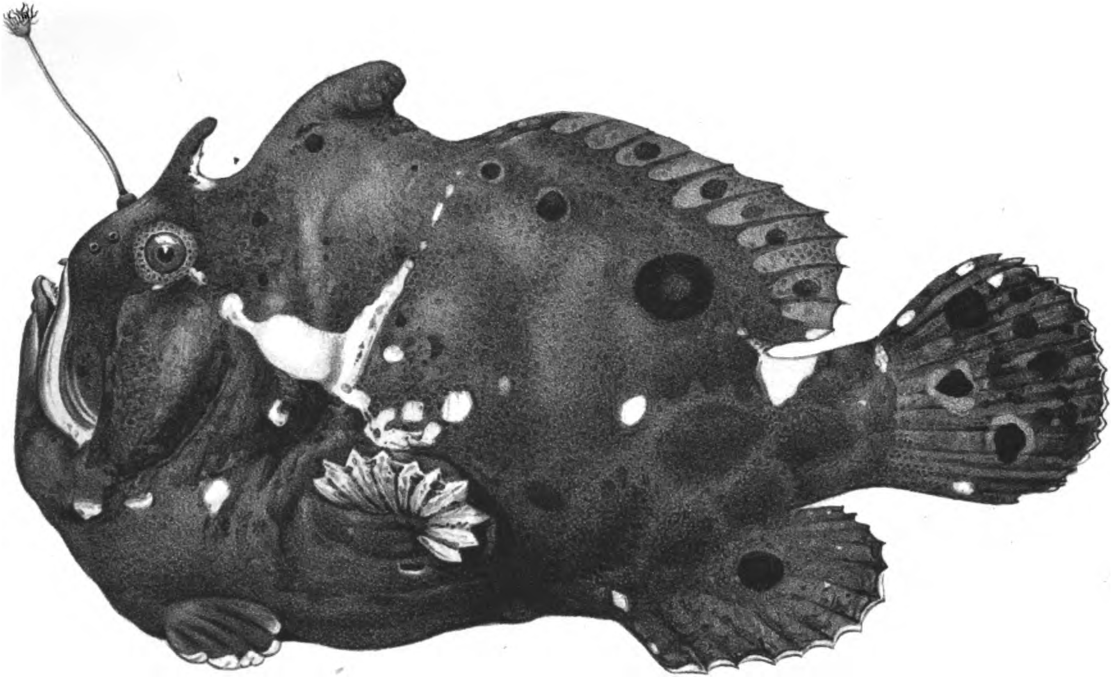

R N Fischer del B Meisel lith

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
H. B. BIGELOW. The Siphonophores.
K. BRANDT. The Sagittae.
" The Thalassicolae.
W. R. COE. The Annelids.
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REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeda.
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W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
J. P. McMURRICH. The Actinarians.
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JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to XLII., and also Vols. XLIV., XLV., and XLVII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVIII., XXIX., XXXI., and XXXII.

Vols. XLIII., XLVI., XLVIII., and XLIX., of the BULLETIN, and Vols. XXV., XXVI., XXVII., XXX., and XXXIII. of the MEMOIRS, are now in course of publication.

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The following publications are in preparation: —

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, in charge of Professor N. S. Shaler.

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Bulletin of the Museum of Comparative Zoölogy
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VOL. XLVI. No. 8.

THE MAMMALS AND BIRDS OF THE PEARL ISLANDS, BAY OF PANAMA.

BY JOHN E. THAYER AND OUTRAM BANGS.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
SEPTEMBER, 1905.

No. 10.—*Reports on the Results of Dredging, under the Supervision of* ALEXANDER AGASSIZ, *in the Gulf of Mexico and the Caribbean Sea, and on the East Coast of the United States, 1877 to 1880, by the U. S. Coast Survey Steamer "Blake,"* LIEUT. COMMANDER C. D. SIGSBEE, U. S. N., *and* COMMANDER J. R. BARTLETT, U. S. N., *Commanding.*

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XLI.

Zur Anatomie von Pentacrinus decorus WY. TH. VON AUGUST REICHENSPERGER.[1]

DAS von mir benutzte Material stammt von der unter Leitung von Alexander Agassiz 1878–1879 zur Erforschung des Karibischen Meeres unternommenen Expedition des "Blake." Es bestand aus 25 zum Teil ganz unverletzten, gestielten Crinoiden, die ich nach P. H. Carpenter (5) sämtlich als "*Pentacrinus decorus*" Wy. Th. bestimmte.

Das Material erwies sich als gut konserviert. Die einzelnen Teile wurden in Schnittserien nach den verschiedensten Richtungen zerlegt. Zur Entkalkung bediente ich mich eines tropfenweisen Zusatzes von konzentrierter Salpetersäure zu relativ grossen oft erneuerten Mengen 70 %igen Alkohols. Mit besserem Erfolg wandte ich sehr schwache Chromsäurelösungen an. Zu 1000 ccm 1 %iger Chromsäure setzte ich 50 Tropfen Salzsäure oder bis 30 Tropfen Salpetersäure zu. Diese Mischung wurde in der ersten Zeit unter täglichem Wechsel auf ein Viertel mit destilliertem Wasser verdünnt, später langsam fortschreitend bis auf höchstens ½ gesteigert. Die durch blosse Anwendung von

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[1] This paper has also been published in Vol. LXXX, Part 1, of the Zeitschrift für wissenschaftliche Zoologie. Specimens of *Pentacrinus decorus* were dredged by the "Blake"—off Havana, 175 and 177 fathoms; off Montserrat, 88 fathoms; and off St. Vincent, 124 fathoms.

Chromsäure leicht hervorgerufene Brüchigkeit der Gewebe war bei Gebrauch jener Mischung nicht zu bemerken. Zum Einbetten wurde ausschliesslich Paraffin genommen.

Als Färbemittel kamen vor allem Boraxkarmin, neutrales Karmin nach Hamann, sowie Hämalaun in Stückfärbung zur Anwendung. Stellenweise erwies sich Hämatoxylin in Verbindung mit Eosin als günstig. Sehr gut eignete sich für alle Gewebe, auch für die Kalkgrundsubstanz eine konzentrierte oder verdünnte wässrige Thioninlösung, ebenfalls unter allenfallsiger Nachfärbung mit Eosin. Thionin gab stets noch brauchbare Resultate, wenn viele andre Färbemittel der vorausgegangenen Entkalkung wegen versagten.

Es ist mir eine angenehme Pflicht, Herrn Geheimrat Professor Dr. Hubert Ludwig hier meinen besten Dank auszusprechen für die Überlassung des seltenen Materials und für seine liebenswürdige Bereitwilligkeit, mich jederzeit mit Rat und Tat zu unterstützen.

Einleitung.

P. H. Carpenter machte zuerst eingehendere Untersuchungen an *Pentacrinus decorus*, deren Ergebnisse in Bd. XI des Challengerwerkes niedergelegt sind. Er führt jedoch selbst verschiedentlich an, zur Erkenntnis des feineren Baues und Verlaufes mancher Organe sei das Material nicht in hinreichend gutem Zustande gewesen.

Zur allgemeinen Orientierung möchte ich zunächst auf die etwas umgeänderte Verkleinerung seiner Taf. LXII verweisen, Taf. III, Fig. 1.

Was die Benennung der Skelettteile des Kelches und der Arme anbetrifft, so verwende ich die von P. H. Carpenter in einer späteren Abhandlung (7) vorgeschlagenen Namen. In dem Challengerwerk (5) lässt er auf die den Boden des Kelches bildenden Basalia die Radialia I, II und III folgen. Von letzteren geht die erste dichotomische Teilung aus, die bei vielen Crinoiden die einzige bleibt. In dem 1890 erschienenen Aufsatz (7) belegt Carpenter die ehemals Radialia II und III genannten Kalkstücke mit dem Namen Costalia I und II. Verzweigen sich die Arme nun weiter, so heissen ihre Glieder bis zur folgenden Teilungsstelle, das sich teilende Glied eingeschlossen, Distichalia. Bei *Pentacrinus decorus* ist in der Regel noch eine dritte Spaltung vorhanden. Von der zweiten Teilung bis zu dieser letzten werden die Glieder als Palmaria bezeichnet. Weiterhin findet keine Verzweigung mehr statt, und die folgenden Glieder des Armes bis zur Spitze heissen Brachialia. Glieder, von denen eine dichotomische Teilung ihren Ausgang nimmt, werden axillare Glieder genannt.

Der Stiel zerfällt in Nodi, welche meist je fünf Cirren tragen, und in Internodia ohne solche.

Die Leibeshöhle des Kelches bildet bei *Pentacrinus decorus* ein zusammenhängendes Ganze, in welchem die Organe von bald stärkeren bald schwächeren Bindegewebssträngen gehalten und umsponnen werden. In diesen Bindegewebssträngen sind Kalkgebilde der verschiedensten Art enthalten, ähnlich, wie solche Ludwig (18) Taf. XVI. Fig. 39, wiedergegeben hat.

Annähernd in der Mittellinie durchzieht das "drüsige Organ," Carpenters "plexiform gland", den Kelch von oben nach unten, um sich in den Stiel fortzusetzen. Diese Fortsetzung des drüsigen Organs bezeichne ich als Achsenstrang; Ludwig gab diesen Namen bei *Antedon* der dorsalen Verlängerung des drüsigen Organs. Der Ausdruck P. H. Carpenters "central vascular axis of stem" birgt dagegen einen weiteren Begriff, da derselbe nicht nur die eigentliche Fortsetzung des drüsigen Organs, sondern auch die Ausläufer des gekammerten Organs darin zusammenfasste (5), S. 107.

Im Bereiche der Basalia ist dem drüsigen Organ das in fünf Teile zerfallende gekammerte Organ rings angelagert, welches sich ebenfalls röhrenförmig in den Stiel verlängert. Endlich treffen wir in den Basalia noch das Zentralorgan, den Knotenpunkt des umfangreichen antiambulacralen oder dorsalen Nervensystems, von welchem starke Stränge ausgehen, die dorsal durch die Kalkteile des Kelches und der Arme verlaufen.

In der Mitte der Kelchdecke liegt die Mundöffnung, in der sich die Ambulacralfurchen der Arme vereingen. Der Schlund geht fast senkrecht nach unten und macht mit seiner Fortsetzung, dem Darm, eine Drehung von links nach rechts. Nachdem der Darm in horizontaler Richtung den Kelch ringförmig durchlaufen hat, steigt er weider nach oben, um im interradial liegenden After zu enden.

Unter dem Epithel der Mundöffnung bemerken wir die oralen Teile des Wassergefass- und Blutgefasssystems und das ambulacrale Nervensystem. Ein weiteres, von Jickeli (15) vom ambulacralen Nervensystem bei *Antedon rosaceus* unterschiedenes, ventrales oder orales Nervensystem, welches Hamann (13) S. 72 später eingehender schilderte, habe ich bisher bei *Pentacrinus* nicht wahrgenommen.

Das für *Promachocrinus* und *Antedon* von P. H. Carpenter (4 und 5) beschriebene "schwammige Organ", welches er als besondern leicht durch dichtere Struktur kenntlichen Teil des labialen Blutgefässgeflechts abtrennt, stellt er selbst bereits für *Pentacrinus decorus* in Abrede (5) S.

100, und auch ich habe vergebens nach ihm gesucht. Dagegen fand ich einen umfangreichen Komplex von Zellen, welcher dem oberen Teil des "drüsigen Organs" angelagert ist. Dieses Komplexes finde ich an keiner Stelle Erwähnung getan, jedoch glaube ich, dass er in einer Zeichnung P. H. Carpenters (5) Pl. LVII, Fig. 3, angedeutet sein soll.

Gut entwickelt ist das "labial plexus" genannte labiale Blutgefässgeflecht, das mit dem oralen Blutgefässsystem in Verbindung steht und zu den intervisceralen Teilen der Leibeshöhle Ausläufer sendet. Ich halte dasselbe mit Ludwig (18) S. 47 nur für einen modifizierten Teil des oralen Blutgefässringes.

Den Bau der Arme fand ich, abgesehen von einer später zu berührenden Ausnahme, in der allgemeinen inneren Organisation im wesentlichen so, wie P. H. Carpenter (5) S. 88 ff., ihn schildert. Ich möchte daher auf das dort Gesagte verweisen.

1. Antiambulacrales Nervensystem.

1. Verlauf in Kelch und Armen.

Betrachten wir zunächst vom Zentralorgan ausgehend das antiambulacrale Nervensystem. Ludwig gab zuerst (18), Taf. XV, Fig. 38, ein Diagramm dieses Systems bei *Antedon rosaceus;* Hamann konstruierte (13) S. 65, ein ähnliches für die Gattungen *Antedon* und *Actinometra.*

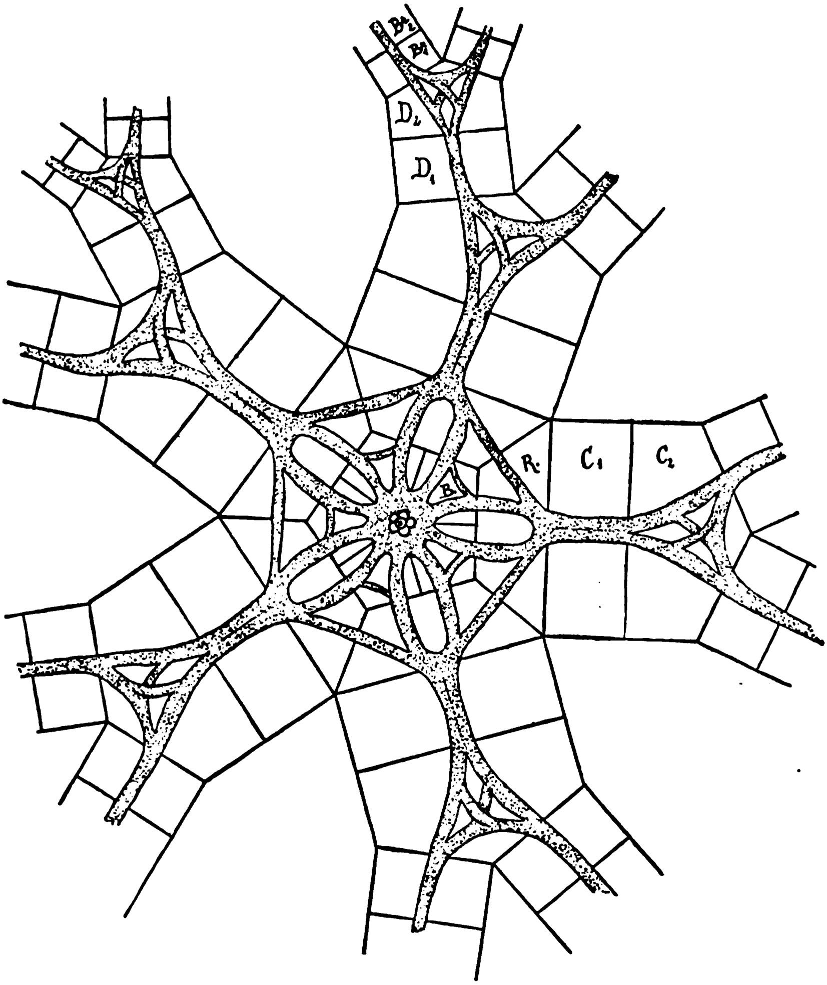
Pentacrinus decorus weist manche Verschiedenheiten von den genannten auf, wie ein Vergleich jener Diagramme mit dem von mir gegebenen dartut. Vgl. nebenstehenden Holzschnitt.

Das Zentralorgan selbst ruht knopfförmig in dem von den Basalia gebildeten Ring. In der Hauptmasse verlaufen seine Fasern von unten nach oben. In der Mitte wird es vom gekammerten Organ durchbrochen, das sich in den Stiel hinunterzieht.

Vom Zentralorgan gehen nun seitlich schräg nach oben hin zehn Äste aus, die, ein weniges divergierend, paarweise durch die Kalkgrundsubstanz der fünf Basalia verlaufen. Ehe sie diese verlassen, werden die beiden Stränge je eines Paares unter sich durch ein Connectiv verbunden, das nur etwa ein Drittel vom Durchmesser der Hauptäste besitzt. Letztere gehen zu je zweien parallel weiter durch die ersten Radialia, um sich an deren distalem Ende zu vereinigen. Die fünf Vereinigungspunkte werden durch einen sehr starken, horizontal verlaufenden Faserring miteinander verbunden. In den ersten Costalia finden wir nur einen Strang, der auf der Ober- und Unterseite meist eine mehr oder weniger flache Längsfurche aufweist, so dass ein Querschnitt durch denselben etwa Biskuitform hat.

In dem axillaren Costale II endlich treffen wir auf das Chiasma nervorum brachialium, dessen Bau bei *Antedon* Ludwig, Hamann und Perrier sehr eingehend geschildert haben.

Zunächst kann ich mit Gewissheit feststellen, dass ein erstes, bisher von andern nicht bestätigtes Transversal-Connectiv, welches Perrier bei *Antedon* fand (21), T. IX, Pl. XVIII, Fig. 147 *cn* 1, bei *Pentacrinus* nicht vorhanden ist. Ferner vollzieht sich die Kreuzung der beiden eigentlichen Chiasmabündel erst sehr spät und in einem eher spitzen wie rechten Winkel. Hierdurch fällt sie erst in das Gebiet des breiten



transversalen Nervenzugs, während sie sich bei *Antedon* vorher vollzieht. Die beiden sich kreuzenden Stränge sind allgemein sehr viel stärker entwickelt wie bei *Antedon*. Man kann deutlich wahrnehmen, dass ein gegenseitiger Faseraustausch in ihnen auch bei *Pentacrinus* nicht stattfindet, vielmehr ein Strang quer über den andern wegläuft.

Bi- und multipolare Ganglienzellen finden sich in den Hauptästen nicht selten, im Chiasma selbst sind sie sehr vereinzelt, aber dann von bedeutender Grösse, 0,012 bis 0,009 mm, und mit starken Fortsätzen versehen.

Ausser den fünf in den axillaren Costalia II befindlichen Chiasmata finde ich keine weiteren erwähnt. Bei zehnarmigen Crinoiden sind sie naturgemäss die einzigen, welche vorhanden sein können. Die Zahl der Arme schwankt bei *Pentacrinus* von 10 bis 25; durchschnittlich teilen dieselben sich zwei- bis dreimal. Wie verhält sich bei diesen weiteren Teilungen der Nervenstrang?

Auf tangentialen Längsschnitten findet man in jedem axillaren Distichale und Palmare ebenfalls ein gut ausgebildetes Chiasma, dessen Dimensionen natürlich mit der Entfernung vom Kelch abnehmen. Die sich kreuzenden Stränge sind aber nicht, wie man erwarten sollte, um die Hälfte, sondern nur um etwa ein Drittel dünner, wie die des vorausgegangenen Chiasma. Nach Messungen an zwei Exemplaren betrug ihr Durchmesser durchschnittlich im:

Chiasma costale	0,118 mm
Chiasma distichale	0,076 mm
Chiasma palmare	0,049 mm

Auf Taf. XXIV des Challenger-Werkes (5) gibt Carpenter verschiedene Querschnitte durch die Basis eines Kelches von *Pentacrinus wyville-thomsoni* wieder, welchem *Pentacrinus decorus* sehr nahe steht. Er zeichnet dort Fig. 9 den horizontal durch die Radialia verlaufenden Faserring, aber keine Connective in den Basalia.

Vergleicht man das von mir gegebene Diagramm von *Pentacrinus decorus* mit den von P. H. Carpenter (5) konstruierten des *Rhizocrinus lofotensis* S. 253, des *Bathycrinus aldrichianus* S. 229, und mit dem von Hamann (13) S. 65 für die Gattungen *Antedon* und *Actinometra* festgestellten, so sieht man, dass das antiambulacrale Nervensystem der beiden ersten Arten ungleich einfacher gebaut ist, wie das von *Pentacrinus*. Bei beiden Arten geht in jedem Basale vom Zentralorgan nur ein Strang aus, der sich bei *Rhizocrinus* unmittelbar vor dem Verlassen der Basalia, bei *Bathycrinus* erst in den Radialia in zwei Äste spaltet.

Dagegen teilt sich bei *Antedon* und *Pentacrinus* jeder Basalstrang sogleich nach dem Austritt aus dem Zentralorgan in zwei Stränge. Während diese aber bei *Pentacrinus* zu je zweien durch ein Connectiv verbunden sind und im übrigen paarweise parallel durch die Radialia verlaufen, fehlt bei *Antedon* das Connectiv in den Basalia, und die zwei Stränge vereinigen sich beim Übergang in das Radiale, um als ein solider Strang weiter zu ziehen.

Allen genannten Familien kommt ein stark entwickelter Faserring in den Radialia zu. Bei *Rhizocrinus* liegt er zum kleineren Teile in den Basalia, wodurch seine Sternform zustande kommt; bei den andern liegt er stets ganz innerhalb der Radialia und hat die Form eines mehr oder minder abgerundeten Pentagons.

Einen Vergleich zwischen dem Verlauf der Faserstränge von *Antedon* und *Encrinus*, für welch letztere, auf dicyklischer Basis beruhende Gattung, Beyrich ein Diagramm konstruierte, zieht Ludwig (18), S. 66, und schliesst von anatomisch-vergleichendem Standpunkt wichtige Bemerkungen an. Er kommt zu dem Schluss, dass der äussere Kreis der eigentlichen Basalia von *Encrinus* den Basalia von *Antedon* entspricht.

Was den Zweck der Connective und sonstigen Verbindungen der Nervenstränge anbetrifft, so scheint mir derselbe an erster Stelle in der Schnelligkeit von Reizübertragungen zu liegen. Ein auf einen Arm ausgeübter Reiz kann unmittelbar auf den benachbarten übertragen werden, ohne zuerst den Weg zum Zentralorgan und von dort zurück machen zu müssen.

Hinsichtlich des feineren histologischen Baues muss ich mich vollständig Perrier (21) und Hamann (13) anschliessen. Der letztere beschreibt (13) S. 87, auch speziell den Bau der Armnerven von *Pentacrinus decorus;* ganze Tiere standen anscheinend nicht zu seiner Verfügung. Ich sehe hier von einer Schilderung des dorsalen Nervenstranges in den Armgliedern ab, da ich den Auseinandersetzungen Hamanns wesentliches nicht hinzuzufügen habe, um mich dem Faserverlauf im Stiele zuzuwenden.

2. Verlauf des Nervensystems im Stiel.

In Fig. 1 und 7 *b* sehen wir, wie das Zentralorgan des antiambulacralen Nervensystems in seiner Mitte von sechs Röhren durchbrochen wird. In der mittleren Kammer verläuft der Achsenstrang; die äusseren fünf sind Fortsetzungen des gekammerten Organs.

Das ganze Bündel von Röhren wird im Stiel seiner Länge nach von einer ziemlich dicken Schicht meist senkrecht von oben nach unten verziehender Nervenfasern umhüllt. Grosse Ganglienzellen trifft man in dieser Schicht während des Verlaufs durch Internodien verhältnismässig selten an; vereinzelte liegen am Aussenrande. Ein Belag stark färbbarer kleiner Kerne trennt in den Internodien fast überall die Faserschicht von der benachbarten Kalkgrundsubstanz der Stielglieder.

In den Nodien, oberhalb und unterhalb der Abgangsstelle der Cirrengefässe, gehen die peripherischen Fasern der Nervenschicht seitlich auseinander, ziehen in der Richtung auf die Gefässe hin und bilden auf diese Weise einen horizontalen Ring, wie Fig. 3 darstellt. In der Substanz dieses bald schwächer, bald stärker ausgebildeten peripherischen Ringes finden wir zahlreiche grosse bi- und multipolare Ganglienzellen. Einmal liegen sie in der Mitte zwischen je zwei Cirrengefässen, dann aber vornehmlich auch unmittelbar neben der Ursprungsstelle der letzteren aus den Kammern. Im weiteren Verlauf bleiben die Cirrengefässe zunächst allseitig ganz gleichmässig von der dem Ringe entstammenden Nervenschicht umhüllt (Fig. 4). Verlassen sie aber das Nodium, um in das erste, eigentliche Cirrusglied überzugehen, so rückt die Fasermasse mehr und mehr auf die Seiten, und oben und unten bleibt nur ein dünner Belag, wie das Fig. 5 zeigt. Derselbe verdickt sich wieder ein wenig an der Stelle, wo in jedem Cirrusgliede, von den vier Ecken der das Gefäss umhüllenden Schicht ausgehend, Nervenzüge zur Innervierung der Haut und der Gelenkverbindungen abgegeben werden.

3. Funktion des antiambulacralen Nervensystems.

Die Funktion des Zentralorgans und der von ihm ausgehenden dorsalen Stränge ist sehr verschieden beurteilt worden. W. B. Carpenter war der erste, der dem gesamten Komplex nervöse Natur beilegte und seine Meinung auch auf eine Reihe von interessanten Experimenten an lebenden Tieren der Gattung *Antedon* zu stützen suchte. Ludwig (18) S. 80 fasste dagegen das dorsale Nervensystem als unverkalkt gebliebenen Teil des skelettbildenden Gewebes mit Nährfunktion auf. Inzwischen wies P. H. Carpenter in den Strängen grosse Ganglienzellen nach und W. B. Carpenter trat nochmals in einer ausführlichen Abhandlung (9) für seine Ansicht ein. Jickeli (15) S. 367, Perrier (21) und Hamann (13) gaben nähere Einzelheiten über den Bau und die Verteilung der bi- und multipolaren Ganglienzellen an, und letzterer beschreibt auch S. 66, 67 die Struktur der feinen Fasern, um zu dem Schluss zu kommen, dass es echte Nervenfasern seien.

A. M. Marshall wiederholte (20) die Experimente, welche W. B.

Carpenter an lebenden Tieren angestellt hatte und fügte eine bedeutende Anzahl neuer hinzu. Er kommt zu der Ansicht, dass das Zentralorgan und seine Verlängerungen das Hauptnervensystem bildeten. Das subepitheliale, ambulacrale Nervensystem scheint ihm nur sehr untergeordnete Bedeutung zu haben (op. cit. S. 35).

Demgemäss wird nunmehr der ganze Komplex fast allgemein als ausschliesslich nervöser Natur angesehen. Allerdings sind in den Strängen keinerlei bindegewebige Elemente anzutreffen, aber dennoch kann ich ohne eine Einschränkung der eben genannten Auffassung nicht beipflichten.

P. H. Carpenter sagt selbst (5) S. 116: "I have no doubt whatever, that the axial cords are permeated by a nutritive fluid, which finds its way into the substance of the organic basis of the skeleton;" und ferner berichtet er von Zweigen, welche ihm überzugehen scheinen: "into the plexus of tissue forming the organic basis of the skeleton." Das nicht seltene Vorkommen solcher Zweige kann ich nur bestätigen. — Mitunter gehen vornehmlich vom dorsalen Armstrang rasch sich verjüngende Ausläufer aus, deren feinste Enden fern von Muskeln oder ähnlich gebauten Fasern im Kalkgrundgewebe verlaufen. Sie besitzen stellenweise eine dünne Decke von kleinen Kernen, dagegen mangeln ihnen grosse Ganglienzellen gänzlich. Fig. 6 gibt dies Verhalten wieder. Vergebens versuchte ich diese Ausläufer bis an die Haut oder wenigstens bis in deren Nähe zu verfolgen.

Häufiger noch und besser sind derartige Abzweigungen in den oberen Teilen des Stieles wahrzunehmen, in welchen die Neubildung weiterer Kalkglieder vor sich geht, wo also die Frage der Ernährung eine bedeutende Rolle spielt. Sie gehen innerhalb des Stieles von dem Nervenstrang aus, der die Cirrengefässe umhüllt, und zwar meist unter einem rechten Winkel nach oben oder unten. Diese Ausläufer verjüngen sich kaum wahrnehmbar und durchziehen weithin die Grundsubstanz fast stets ohne sich zu verzweigen. Sie sind von zahlreichen Kernen begleitet und stellenweise mit winzigen stark tingierbaren Körnchen übersät, deren Natur mir einstweilen zweifelhaft erscheint, die ich aber jedenfalls für ein Coagulum halten möchte. Auch P. H. Carpenter fand solches häufig in den Nervensträngen (5) S. 116. Die Fasermasse der Ausläufer ist gering entwickelt, aber unverkennbar vorhanden. Ganglienzellen habe ich an oder in diesen Zügen niemals zu Gesicht bekommen.

Da mir in den genannten Fällen eine Innervierung sensitiven oder motorischen Charakters ausgeschlossen scheint, halte ich eine trophische Nebenfunktion der Stränge für sehr wahrscheinlich.

Hamann wies bereits aufs bestimmteste (13) S. 68 die Behauptung von Vogt und Yung zurück, es stellten die Nervenstränge bei *Antedon rosaceus* mit geronnener Flüssigkeit erfüllte Röhren von weitem Lumen dar (25) S. 560, Fig. 277. Für *Pentacrinus* kann ich nur nochmals mit P. H. Carpenter (5) S. 113 ff. feststellen, dass es sich lediglich um solide Faserstränge handelt, die weder Hohlräume noch Scheidewände aufweisen.

II. Das "gekammerte Organ" und die Cirrengefässe.

Eine Zusammenfassung der Ansichten der verschiedenen Forscher über das gekammerte Organ von *Antedon* gibt Hamann (13) S. 101. Bei *Pentacrinus decorus* besteht es aus fünf Kammern oder richtiger Röhren, welche sich nach unten verengen und in den Stiel fortsetzen, nach oben hin den Achsenstrang und weiterhin das "drüsige Organ" (Dorsalorgan) umfassen, um bald blind zu endigen.

Verfolgen wir Gestaltung und Verlauf an der Hand der Abbildungen. Fig. 7 *a* zeigt einen Querschnitt im Stiel. Fünf Röhren liegen mit ihrer Aussenwandung im Kreise seitlich aneinander und bilden in der Mitte eine sechste Kammer, in welcher der Achsenstrang verläuft. Figur *b* und *c* zeigen, wie weiter oberhalb, bei Übergang in den Kelch, die Kammern an Grösse zugenommen haben und bereits von der Fasermasse des eigentlichen Zentralorgans umhüllt sind. Die folgende Zeichnung *d* gibt einen Querschnitt in Höhe des in den Basalia befindlichen Nervenconnectivs wieder. Der Kelch hat sich hier erweitert und seine Höhlung ist von kalkführendem Bindegewebe nach allen Richtungen durchzogen, welches an die Aussenwände der fünf Kammern herantritt. Letztere haben sich voneinander getrennt und vom Achsenstrang etwas entfernt. Später nähern sie sich der Mitte wieder, jede Kammer verjüngt sich rasch, und ihre Wandung geht in das Cölomepithel über, welches das drüsige Organ umhüllt. Ihr Hohlraum dagegen findet keinerlei Fortsetzung, weder im drüsigen Organ, noch in der Leibeshöhle, wird vielmehr durch feines Bindegewebe nach oben abgeschlossen (Fig. 7 *g*).

Bei *Antedon* fand W. B. Carpenter (8) S. 219, ventralwärts eine Öffnung in jeder Kammer und brachte letztere daher mit der Leibeshöhle in Verbindung. Ludwig beobachtete Kanäle, welche sich den ventralen Öffnungen W. B. Carpenters anschlossen, um zum Achsenstrang, bzw. drüsigen Organ hinzuziehen (18) S. 63 und Fig. 21. Ebenso hält P. H. Carpenter (5) S. 104 das gekammerte Organ für fünf Radiärgefässe, welche sich verbreitern und mit dem drüsigen Organ in enger Beziehung stehen. Perrier (21) S. 24 ff. verfolgte die allmähliche Entwicklung des gekammerten Organs bei *Antedon rasaceus* und kommt zu dem Schlusse, dasselbe bilde einen geschlossenen Raum, der sich nicht in das drüsige Organ fortsetze. In gleichem Sinne spricht sich Hamann (13) S. 103 aus: "Es gehen von dem eigentlichen gekammerten Organ fünf blindgeschlossene röhrenförmige Hohlräume ab, welche neben dem axialen Strang verlaufen, um bald blind zu endigen, wie ich mit grösster Sicherheit aussprechen kann (Taf. VII, Fig. 1)."

Bei *Pentacrinus decorus* habe ich in den Wandungen des gekammerten Organs keinerlei Öffnungen gefunden, auch fehlen die bei *Antedon* nach oben hin sich erstreckenden röhrenförmigen Verlängerungen oder Kanäle; vielmehr endet das Organ fast unmittelbar nachdem es seine grösste Breite erlangt hat. Dieser Unterschied von *Antedon* ist offenbar nur quantitativer Art, indem eine Verkürzung der Röhren oder Kanäle bei dieser Art zu der Form des Organs führen würde, wie wir sie bei *Pentacrinus* angetroffen haben. Wahrscheinlich wird bei letzterem eine solche Verlängerung nach oben unterdrückt durch das die ganze Kelchhöhle erfüllende Bindegewebe, welches bei *Pentacrinus* ungleich stärker wie bei *Antedon* entwickelt ist.

Im obersten Teile der Kammern bemerkt man im Innern von Wand zu Wand ziehend unverkalktes, feinfaseriges Bindegewebe. Ausserdem findet man überall im Innern zerstreut zahlreiche, grosse, tiefdunkle Körner von amorpher Gestalt. Dieselben bilden ein nicht zu verkennendes Merkmal für alle zum gekammerten Organ gehörigen Teile. Nirgends sonst sind derartige Gebilde anzutreffen, weder in benachbarten Teilen des drüsigen Organs, noch im umgebenden Bindegewebe der Leibeshöhle. Dies scheint mir ein Beweis mehr dafür zu sein, dass die Kammern ein in sich geschlossenes Ganze bilden. Auch Perrier (21) S. 24 ff. stellte ähnliche Körner bei *Antedon rosaceus* fest, und sagt, er habe sie ausschliesslich auf das gekammerte Organ beschränkt gefunden, was demnach vollständig mit meinen Beobachtungen in Einklang steht.

In den Nodien des Stiels geht von jeder Kammer des Organs, bzw. seiner Verlängerung, ein Gefäss in die Cirren ab. Einen Teil eines horizontal durch ein Nodium geführten Schnittes gibt Fig. 8 wieder, einen Teil eines Vertikalschnittes Fig. 9. Die Fortsetzungen der Kammern nehmen in den Nodien etwas an Umfang zu. Ihre distale Wandung biegt nach aussen hin aus und zeigt eine länglich ovale Öffnung, den Beginn der Cirrengefässe. Das Epithel der Kammern setzt sich in letztern ringsum fort und kleidet ihre Innenwand aus.

Jedes Gefäss wird von einem horizontal durch die Mitte laufenden Septum in eine obere und eine untere Hälfte geteilt. Das Septum bildet sich von der proximalen Kammerwand her und durchquert die Kammer. Es besteht aus einer sehr feinen Bindegewebslage, die beiderseits mit einem epithelartigen Belag von Zellen versehen ist. Seine Dicke schwankt zwischen 0,0048 und 0,0067 mm. Muskelfasern habe ich nicht in ihm gefunden. — Zu Anfang zeigen die Cirrengefässe im Querschnitt eine länglich ovale, von oben nach unten gestreckte Form, runden sich aber bald ab. Mit dem Achsenstrang stehen sie bei *Pentacrinus decorus* in keinerlei Beziehung.

Unter den mir vorliegenden Exemplaren befand sich eines mit stark verkümmerter fünfter Kammer. Demgemäss hatten sich an jedem Nodium nur vier Cirren entwickelt. Selbst die Gelenkgrube zur Aufnahme des ersten Cirrusgliedes, die bei *Pentacrinus* im allgemeinen stark ausgebildet ist, war an der fünften Seite kaum wahrzunehmen.

Für Erkenntnis der noch immer fraglichen Funktion des gekammerten Organs, das Hamann mit Bury seiner Entstehung nach als Enterocölraum ansprechen möchte (13) S. 107, wäre es von Bedeutung, zu wissen, wie es sich im letzten Stielgliede verhält. Da bei allen mir zur Verfügung stehenden Tieren der Stiel weiter oberhalb abgebrochen war, konnte ich nicht feststellen, ob die Kammern an ihrem unteren Ende gleichfalls geschlossen sind, oder ob sie mit der Umgebung in freier Kommunikation stehen. Letzteres scheint mir weniger wahrscheinlich, da auch bei *Antedon* und *Actinometra* das gekammerte Organ, abgesehen von den Ausgängen der in die Cirren führenden Gefässe, nach unten hin geschlossen ist, wie Hamann (13) S. 104 mitteilt.

Cuénot (10), Bosshardt (3) S. 105 und andre berichten, dass die Bewegungen der Cirren von *Antedon* sehr zögernd und langsam erfolgen und dieselben sich in dieser Beziehung in weitgehender Weise von denjenigen der Arme unterscheiden. Im vollen Gegensatz hierzu erwähnt A. Agassiz von einer Anzahl *Pentacrinus*, die er während einiger Stunden lebend hielt: "They use the cirri more rapidly, then the arms, and use them as hooks, to catch hold of neighbouring objects. . . ." — Weitere Angaben über die Bewegungen der Cirren bei den gestielten Crinoiden liegen meines Wissens nicht vor.

III. Das "drüsige Organ" (Dorsalorgan).

1. DER ACHSENSTRANG.

In der Röhre, welche in der Mitte des kalkigen Stieles liegt, und die von den fünf Kammern des gekammerten Organs gebildet wird, befindet sich ein langer dünner Strang, P. H. Carpenters axis of stem im engeren Sinn, den ich nach Ludwig als Achsenstrang bezeichne. Seine Fortsetzung im Kelch bildet das drüsige Organ. Genauere Einzelheiten finde ich bei P. H. Carpenter über den Bau dieses Stranges nicht angegeben. Er rechnet ihn anscheinend zum gekammerten Organ und sagt nur (5) S. 107, derselbe bilde in den Stielteilen "a singular vessel (5) Pl. XXIV, fig. 2—5 *V*.

Bei den mir vorliegenden Exemplaren von *Pentacrinus* beträgt der Durchmesser des Achsenstrangs etwa 0,009–0,0165 mm, und zwar verjüngt er sich nicht nach unten hin, sondern hat, soweit ich ihn durch den Stiel verfolgen konnte, überall annähernd gleichen Umfang. Er setzt sich aus ursprünglich kugeligen Zellen zusammen, die sich seitlich gegeneinander abplatten. Fig. 11 bringt einen Quer-, Fig. 10 einen Längsschnitt. Man bemerkt auf ersterem eine einreihige, ringförmige Zellschicht, welche in der Mitte ein unregelmässig gestaltetes, stets sehr kleines Lumen freilässt. Die Zellgrenzen sind nur undeutlich zu erkennen. Der Zellinhalt ist fein granuliert, wie auch der Inhalt der Kerne. In letzteren befinden sich meist noch grössere Körnchen, deren Zahl schwankend ist. Die Gestalt der Kerne ist länglich oval. Sie lagern sich im allgemeinen gegen das innere Lumen hin. Ihre Grösse bewegt sich zwischen 0,0011 · 0,0031 und 0,002 · 0,0043 mm.

Der Achsenstrang hängt seiner ganzen Länge nach frei in dem von den Fortsetzungen des gekammerten Organs gebildeten Raume; es ist mir wenigstens nicht gelungen, Fasern oder bindegewebige Stränge zu finden, die an ihn seitlich von den Kammerwänden her herantreten. Ebensowenig fand ich in diesem Raume die oben erwähnten für das gekammerte Organ bezeichnenden dunkeln Körner; es scheint demnach auch im Stiel keine Kommunikation zwischen den Fortsetzungen des gekammerten Organs und der Röhre des Achsenstrangs zu bestehen.

2. Das eigentliche "drüsige Organ."

Schon ehe der Achsenstrang in den Kelch übergeht, hat sich sein Umfang etwas vergrössert. An Stelle der einfachen Zellreihe treten mehrere Schichten. In diesen bilden sich Faltungen, so dass das innere Lumen halbmondförmig wird (Fig. 7 *d*). Weiter nach oben hin kann man zwei, vier und mehr Lumina erkennen. Es kommt sehr bald zur Bildung einer grösseren Zahl von Schläuchen, die sich im weiteren Verlauf verzweigen und in ihrer Gesamtheit kleine Krümmungen machen. In Höhe der Darmwindung finden sich dann häufig **S**- und **U**-förmige seitliche Ausbiegungen einzelner Schläuche, die sich regellos durcheinander schlingen. Sie bedingen den verwickelten Aufbau des drüsigen Organs, dessen Zusammensetzung bei *Antedon* nach Perrier (21) Pl. XX, Fig. 162, einfacher zu sein scheint. Die allgemeine Richtung der Schläuche ist auch bei *Pentacrinus* von unten nach oben, doch gehen nicht selten in horizontaler Richtung kürzere Ausläufer ab, welche bald blind endigen. Ob alle Schläuche miteinander kommunizieren, ist mir zweifelhaft geblieben; für eine beschränkte Anzahl kann man auf günstigen Längsschnitten einen Zusammenhang nachweisen.

Solange die Schläuche im Boden des Kelches nicht sehr zahlreich sind, treten sie zu einer bald kreisförmigen, bald mehr eckigen Röhre zusammen, deren ziemlich weites Lumen von einem Netzwerk von zartem Bindegewebe durchquert wird (Fig. 7 *g* und *h*). Die zunehmende Zahl der Schläuche lässt das Lumen bald enger werden; das Bindegewebe verschwindet. An seiner umfangreichsten Stelle, die bei *Pentacrinus* zwischen der Darmwindung liegt, setzt sich das drüsige Organ folgendermassen zusammen: Aussen gegen die Leibeshöhle hin treffen wir zunächst das umhüllende Cölomepithel; nach innen zu folgt die Masse der teils quer-, teils längsgetroffenen Schläuche. Ungefähr in der Mitte dieser ziemlich kompakten Masse findet sich ein freies Lumen, von Vogt und Yung (25) S. 562 "leere Achse" genannt. Gegen diese ist die Gesamtheit der Schläuche wiederum durch ein mit dem Cölomepithel übereinstimmendes Epithel begrenzt. Ich möchte nach allem die "leere Achse" als einen abgekapselten Teil der Leibeshöhle betrachten, eine Ansicht, die allerdings nur durch entwicklungsgeschichtliche Arbeit mit voller Sicherheit bewiesen werden kann. Bindegewebe ist sehr spärlich zwischen den einzelnen Schläuchen vorhanden, vor allem im untersten Teil des drüsigen Organs. An keiner Stelle fand ich die Schläuche ganz von dichtem Bindegewebe umhüllt, wie das Hamann (13) S. 114, und Taf. IX, Fig. 4, 5, 12 und 13 von *Antedon* darstellt; nur eine feinfaserige bindegewebige Membran mit spärlichen Kernen umzieht bei *Pentacrinus* jeden Schlauch nach aussen hin, wie das durch meine Fig. 13 veranschaulicht ist.

Ziemlich weitgehende Übereinstimmung herrscht bei beiden Gattungen im Bau der Schläuche selbst. Die zylindrischen Zellen, aus welchen die Wand der letzteren gebildet wird, erscheinen, abgesehen von ihrer viel bedeutenderen Grösse, den Zellen des Achsenstranges ähnlich. Sie werden bis 0,042 mm hoch, bei einer durchschnittlichen Breite von 0,016 mm. Die Kerne liegen im allgemeinen mehr der Aussenseite des Schlauches zu. Die Substanz der Zellen zeigt eine feinere, die der Kerne eine gröbere Körnelung. In den oberen Teilen des drüsigen

Organs trifft man im Innern der Schläuche mitunter feines Gerinnsel an, was mir auf einen Zusammenhang mit dem Blutgefässsystem hinzudeuten scheint.

3. DER DEM DRÜSIGEN ORGAN ANGELAGERTE ZELLKOMPLEX.

Verfolgen wir das drüsige Organ von seiner breitesten Stelle an weiter nach oben hin, so treffen wir sehr bald auf einen merkwürdigen Komplex von Zellen, den ich nirgendwo erwähnt order beschrieben finde. Der Umfang desselben schwankt bei den einzelnen Tieren ziemlich bedeutend; seine Form bleibt im allgemeinen annähernd die gleiche. Eine Andeutung dieses Komplexes glaube ich nur bei P. H. Carpenter (5) Pl. LVII, Fig. 3 zu finden. Er rechnet ihn offenbar zu seinem "labial plexus" und lässt das mit *gv* bezeichnete Genitalgefäss aus ihm entspringen.

Die erwähnte Zellmasse bildet eine mehr oder weniger umfangreiche, ovale, stark ausgebuchtete Scheibe von verschiedener Dicke, die sich mit ihrem unteren Rande und den Seitenrändern meist vertikal an das drüsige Organ anlegt. Ventralwärts, in der Nähe der Mundöffnung jedoch, hängt sie mit den Endausläufern des drüsigen Organs nicht zusammen. Letzteres bildet also mit dem Zellkomplex einen oben offenstehenden Sack. Im Innern desselben treffen wir vereinzelte, schwach entwickelte, unverkalkte Bindegewebsstränge und eine grosse Anzahl feinerer Blutgefässe an. Die Wiedergabe eines Längs- und eines Querschnittes, Fig. 15 und Fig. 14, verdeutlicht das Verhalten der einzelnen Teile.

P. H. Carpenter schildert (5) S. 100 das labiale Blutgefässgeflecht, labial plexus, welches mit dem oralen Blutring in Verbindung steht und sich aus einer Menge feiner und feinster Röhren zusammensetzt. Von einem Teile desselben treten Gefässe von oben her in den Sack ein und wenden sich nach allen Seiten zu den Innenwänden; einerseits münden sie an Stellen des drüsigen Organs, anderseits in den erwähnten Zellkomplex. Stellenweise sind sie in solcher Anzahl vorhanden, dass fast der ganze Innenraum des Sackes ausgefüllt ist. Ob diese Blutgefässe mit den Schläuchen des drüsigen Organs in direkter Verbindung stehen, konnte ich nicht mit Gewissheit feststellen, halte es aber für sehr wahrscheinlich; dass sie aber in das spärlich vorhandene umgebende Bindegewebe eindringen und sich dort verzweigen, habe ich mit Sicherheit wahrgenommen. Dagegen bestreitet Hamann (13) S. 114, entschieden ein Eintreten der Blutflüssigkeit in die Lumina der Schläuche bei *Antedon*, um dann fortzufahren: "sie kann höchstens in der Bindesubstanz des Organs ihren Verlauf nehmen, doch habe ich sie auch hier nicht beobachten können."

Mit Gewissheit gelang es mir ferner, mich davon zu überzeugen, dass die zu dem fraglichen Zellkomplex gehenden zahlreichen Blutgefässe in diesen eintreten. Betrachten wir den Bau desselben etwas genauer. Sein Aussenepithel setzt das des drüsigen Organs unmittelbar fort und zeigt die gleichen Zellelemente; sie sind bald mehr kubisch, bald etwas abgeflacht und besitzen deutliche Kerne. Unter dem Epithel verlaufen stellenweise in verschiedenen Richtungen bindegewebige Gefässe. Weiter nach innen folgt ein solides Polster von ziemlich grossen, dicht zusammenschliessenden Zellen, wie Fig. 16 zeigt. Dieselben sind rundlich bis polygonal gegeneinander abgegrenzt. In der Mitte der Scheibe befinden sich grössere, rings nach dem Rande zu kleinere Zellen. Sie färben sich etwas weniger intensiv, wie die Elemente des drüsigen Organs. Ihre Kerne sind von verhältnismässig bedeutender Grösse.

Die Grösse des gesamten Zellkomplexes, der auf etwas dickeren Schnitten schon mit blossem Auge leicht kenntlich ist, schwankt sehr erheblich; im allgemeinen findet man ihn bei weiblichen Tieren ein wenig stärker ausgebildet wie bei männlichen. Der am kräftigsten entwickelte hatte nach meinen Messungen eine durchschnittliche Dicke von 0,077 mm; seine Breite betrug 1,058, seine grösste Länge 2,414 mm. Einer der kleineren Komplexe hatte dagegen nur 0,048 mm Dicke, 0,73 mm Breite und etwa 1,54 mm Länge. Ebenso verschieden der Grösse nach verhielten sich die Elemente, welche das aus 8–14 Zellreihen bestehende Polster bildeten. Bei einem sehr gut konservierten weiblichen Exemplar liess eine Eisenhämatoxylinfärbung genaue Messungen zu. Demnach bestimmte ich die Grösse einzelner Zellen und ihrer Kerne auf:

Zelle	Kern
0,0076 mm	0,0037 mm
0,0078 "	0,0035 "
0,0095 "	0,005 "
0,0103 "	0,0062 "
0,0109 "	0,0068 "
0,0112 "	0,0068 "
0,0132 "	0,007 "
0,0184 "	0,0088 "
0,0187 "	0,0091 "

Aus der Mitte der Aussenfläche der Scheibe geht ein Gefäss von beträchtlichem Durchmesser hervor. Es verläuft in Richtung auf die

Kelchdecke hin und hält sich meist zunächst in der Nähe des Schlundes, um sich später mit Genitalgefässen in Verbindung zu setzen. Dasselbe ist aus einer ziemlich starken Bindegewebsschicht gebildet und zeigt ein deutliches Aussenepithel. Auch im inneren Lumen finden sich mitunter sehr feine Bindegewebsstränge; ob diese bereits hier eine besondere Innenröhre bilden, wie das in den Genitalsträngen der Fall ist, oder nur von Wand zu Wand ziehen, ist mir sehr zweifelhaft geblieben. Helleres und dunkleres Gerinnsel trifft man in dem Gefäss sehr häufig an.

Der Zellkomplex setzt sich nach oben hin bis unterhalb des Integuments der Kelchdecke fort. Seine Dicke nimmt langsam ab. Neben der Mundöffnung angelangt macht er eine fast rechtwinklige Biegung und steht als sehr feiner Strang anscheinend mit dem zwischen dem ambulacralen Nervensystem und dem Wassergefässsystem verlaufenden oralen Blutgefässring in engerer Verbindung.

Diesen bei *Pentacrinus decorus* dem drüsigen Organ angelagerten Zellkomplex halte ich nun für den Bildungsherd der Urkeimzellen, eine Meinung, die ich in den folgenden Abschnitten ausführlicher zu begründen hoffe. Zugleich möchte ich zeigen, dass Blutgefässsystem und Genitalgefässsystem in engem Zusammenhang miteinander stehen. Ich wende mich zu diesem Zweck an erster Stelle der Anordnung und dem Bau der Generationsorgane in den Armen zu, da derselbe dort am deutlichsten erkennbar ist.

IV. Die Generationsorgane.

1. Bau und Verlauf der Genitalstränge in den Armen und Pinnulae.

Bei P. H. Carpenter (5) S. 110 finde ich folgende Bemerkung: "... The ovaries of the *Pentacrinidae* are likewise long and fusiform, some of them appearing to present somewhat anomalous characters. For in some sections, which were made for Sir Wyv. Thomson by Dr. Stirling, the ovary appears in the arm, occupying the usual position between the subtentacular and the coeliac canals, where the sterile genital cord is normally found. This is also the case in the lower parts of the arms of *Holopus rangi*, Pl. V, *c*, fig. 2, but I have not yet succeeded in discovering which species of *Pentacrinus* or *Metacrinus* is distinguished by this peculiarity; for the sections above mentioned were not labelled with any name or reference number. I have cut sections of the arms of all the more common *Pentacrinus*, but in none of them have I found any such departure from the type of the ordinary *Antedon* as is presented by the ovaries of this unknown species."

Lang, (16) S. 1090, nimmt wohl auf diesen Passus bezug, wenn er einer ausnahmsweisen Reifung von Gonaden im Arme einer unbekannten Art Erwähnung tut.

Pentacrinus decorus ist nach allen von mir untersuchten Exemplaren getrenntgeschlechtlich und zwar bargen die Arme in ihrem ganzen Verlauf nahezu reife männliche oder weibliche Geschlechtsprodukte, ja bereits in den meisten Kelchscheiben waren solche vorhanden. Ich kann daher eine Anormalität nicht annehmen, halte vielmehr den Zeitpunkt des Fanges der mir vorliegenden Tiere für besonders günstig gelegen. Gehen wir im folgenden näher auf die Einzelheiten ein.

In dem zwischen Dorsal- und Ventralkanal befindlichen Genitalkanal — ich wähle die Bezeichnungen, die Ludwig (18) einführte — verläuft ein dünnwandiger Schlauch, der ein weites Lumen besitzt. Derselbe wird durch bald stärkere bald schwächere Bindegewebsstränge in der Mitte des Genitalkanals aufgehangen. In diesem Schlauch befindet sich ein engerer mit sehr feiner Wandung. In dem Stadium der Geschlechtsreife, in welchem die von mir untersuchten Tiere sich befanden, erfüllte der innere Schlauch fast das ganze Lumen des äusseren. Die Aussenwand des inneren Schlauches liegt dann zum weitaus grössten Teile der Innenwand des äusseren Schlauches an, so dass sie oft sehr schwer erkennbar ist. Nur nach oben zum Ventralkanal hin bleibt ein freier Raum zwischen den Wandungen, dessen Durchmesser bei vorgeschrittener Entwicklung der Keimzellen etwa ein Viertel des Ganzen beträgt. Die Fig. 17, 18 und 19 geben hiervon ein Bild.

Bereits Ludwig, dem wir die ersten genauen Beobachtungen über den Bau der Generationsorgane von *Antedon* verdanken, hielt den äusseren Schlauch, welcher die eigentliche Genitalröhre umschliesst, für zum Blutgefässsystem gehörig und bezeichnete ihn als Genitalgefäss oder Genitalschlauch, (18) S. 30 ff. Andrer Ansicht ist Hamann, (13) S. 117 und 118, der ein Vorhandensein von Blutflüssigkeit im Genitalschlauch der Crinoiden in Abrede stellt und keinen Zusammenhang mit den Blutlakunen der Scheibe auffand. Ich muss entschieden Ludwig beipflichten. Fast regelmässig fand ich bei *Pentacrinus* feine Körnchen, Gerinnsel, Reste von Blutserum in den Genitalgefässen, wie das aus den Figuren ersichtlich ist. Ferner ist der Bau derselben dem der echten Blutgefässe gleich. Die dünne, aus bindegewebigen Längsfasern gebildete Wand ist von einem feinen Aussenepithel überzogen, dessen Kerne ziemlich dicht aneinanderlagern und scharf hervortreten. Endlich stehen die Genitalgefässe des Kelches in enger Beziehung zu dem labialen Blutgefässgeflecht, wie wir weiter unten sehen werden.

Ringmuskeln, wie sie Ludwig bei *Antedon* (18) S. 31 erwähnt, habe ich in der Wandung der Gefässe nicht gefunden. Auch ist bei *Pentacrinus decorus* die Genitalröhre nicht im Genitalgefäss durch feine, spindelförmige Fasern aufgehangen, wie Ludwig (18) Taf. XIII, Fig. 14 von *Antedon* darstellt, sondern sie liegt, wie oben gesagt, zum grössten Teil der Innenwand des Gefässes an.

Die Genitalröhre besteht aus einer sehr schwachen mit kleinen zerstreuten Kernen versehenen einfachen Bindegewebslamelle. In ihrem Innern befinden sich Samen- oder Eizellen, und zwar trifft man in einem Arme im allgemeinen zwei sehr verschiedene Stadien der Eizellen an, umfangreiche Zellen von etwa 0,135 mm und gering entwickelte von rund 0,028 mm Durchmesser. Es wäre denkbar, dass letztere zu Nahrungszwecken resorbiert werden, jedoch könnten diese kleineren Keimzellen auch eine später folgende Generation bilden, da ich direkte Verfallstadien an ihnen nicht konstatieren konnte. In weiter distal liegenden Teilen der Arme und in den Pinnulae finden sich meist nur Eier einer Grösse vor. Weder in den Pinnulae, noch in Armen oder Kelch findet sich eine Follikelbildung, wie Perrier für *Antedon rosaceus* (21) Pl. 19, Fig. 156 und 157 angibt.

Vollkommen reife Eier, d. h. solche, deren Keimbläschen verschwunden war, und die bereits Richtungskörperchen ausgestossen hatten, wie Hamann (13) S. 121 und Taf. XII, Fig. 4 *a* von *Antedon eschrichti* beschreibt und zeichnet, waren bei meinen Exemplaren noch nicht vorhanden. Die weiter unten folgende Tabelle lässt aber erkennen, wie das Keimbläschen im Verhältnis zu der ganzen Eizelle in den Brachialia höherer Ordnung an Grösse abnimmt. Die in der Entwicklung vorgeschrittenen Eier zeigen fast stets im Keimfleck zwei bis fünfzehn stark lichtbrechende Körnchen, wie das Ludwig bereits von *Antedon* erwähnt, (18) S. 35.

In den Pinnulae erleidet der Genitalstrang bei allen von mir zerlegten Tieren keine Veränderung; höchstens wird das Lumen des Genitalgefässes noch mehr reduziert, da die Genitalröhre zuweilen etwas an Umfang zunimmt. Eine Ausbauchung oder Anschwellung der Pinnulae bestand weder innerlich noch äusserlich. Leider ist es mir auch bisher trotz zahlreicher, in jeder Richtung geführter Schnitte nicht gelungen, präformierte Öffnungen oder Anlagen zu solchen für den Austritt von Geschlechtsprodukten zu finden. So blieb mir die Art und Weise der Eiablage von *Pentacrinus* fraglich. In den Pinnulae durchzieht der Genitalstrang in der Regel nur die ersten zwei oder drei, seltener vier proximalen Glieder, und zwar besitzt er im ersten und zweiten Gliede im allgemeinen den grössten Durchmesser. Dann verjüngt er sich stetig und läuft bei männlichen Tieren in eine Spitze aus, die durch Bindegewebe von den Wänden des Genitalkanals her gehalten wird. Bei weiblichen Exemplaren ist das Ende des Stranges mehr abgerundet und gleichfalls von Bindegewebe gehalten.

In den Armen scheint der Genitalstrang meist nur bis zum acht- oder zwolftletzten Brachiale zu reichen. Genaues hierüber ist schwer festzustellen, da die letzten Brachialia meist abgebrochen sind; der Strang findet seinen Abschluss wie in den Pinnulae.

Unterziehen wir nunmehr die Generationsorgane der männlichen Tiere einer näheren Betrachtung und werfen wir nochmals einen Blick auf die Fig. 18 und 19, welche einen Längs- und einen Querschnitt durch einen Teil eines Armes zeigen, der männliche Keimzellen enthält. Auch hier wird das Lumen des die Genitalröhre umhüllenden Genitalgefässes nur ventralwärts freigelassen; fast drei Viertel des letzteren werden durch die Genitalröhre ausgefüllt. Der Durchmesser derselben schwankt in den Armen zwischen 0,065 und 0,112 mm. Die Grösse der männlichen Keimzellen beträgt 0,002 bis 0,004 mm. Sie zeigen in jüngeren Stadien in der Mitte einen ziemlich grossen Kern, der sich bedeutend dunkler färbt, wie das ihn umgebende Plasma. Die bereits weiter entwickelten Spermatozoen waren nur als runde dunkle Körner sichtbar, an denen ich fadenförmige Fortsätze nicht bemerken konnte.

Leistenförmige Vorsprünge der inneren Fläche der männlichen Genitalröhre, die bei *Pentacrinus decorus* gleich der weiblichen nur von einer dünnen Bindegewebslamelle ohne Innenepithel gebildet wird, sind nicht vorhanden. Ludwig (18) S. 36 schildert diese Vorsprünge in den Testikeln der Pinnulae von *Antedon eschrichti* und illustriert die Beschreibung durch die Fig. 48 und 49 auf Taf. XVII.

Wenig abweichend hiervon beschreibt Ed. Perrier (21) den Bau der männlichen Genitalröhren in den Pinnulae von *Antedon rosaceus*: " . . . Le testicule lui même est formé d'un grand nombre de colonnes de cellules, colonnes cylindriques, ou légèrement renflées en massue, et dont la base est presque exactement circulaire. Ces colonnes résultent d'une invagination en doigt de gant de l'épithélium testiculaire. . . ."

Bei *Pentacrinus* ist, wie gesagt, der Bau der männlichen Generationsorgane sowohl in den Armen wie in den Pinnulae dem der weiblichen gleich. Die männlichen Keimzellen liegen dichtgedrängt regellos rings neben der einfach gebauten Wandung und lassen nur zuweilen in der Mitte der Genitalröhre ein kleineres oder grösseres Lumen frei, wie aus Fig. 19 ersichtlich ist.

2. Der Genitalstrang beim Übergang der Arme in den Kelch.

Gehen wir nun zu den Teilen des Armes über, welche proximal, d. h. näher am Kelch gelegen sind, wie die eben geschilderten Partien, also etwa zu den ersten Brachialia. Im allgemeinen trifft man hier in der Genitalröhre kleine Strecken ohne Keimzellen an; die beiden Schläuche haben sich etwas verengt. Ein Ei in der Grösse von rund 0,09 mm füllt fast das gesamte Lumen aus. Je mehr wir uns weiterhin der Scheibe zu bewegen, um so grösser werden die Strecken, auf denen keine Keimzellen vorhanden sind; kommen solche vor, so besitzen sie immerhin noch eine Grösse von 0,045 bis 0,055 mm und mehr. Die innere Weite des Genitalgefässes beträgt hier durchschnittlich 0,006 mm.

Beim Übergang in die Kelchscheibe verengt sich wie bei *Antedon* der ganze Genitalkanal erheblich. Der in ihm befindliche Doppelschlauch kann sich seitlich nur wenig ausdehnen. Gezwungenermassen nehmen die Genitalzellen eine länglich gestreckte Form an: 0,04 · 0,0495 mm, 0,036 · 0,048 mm, Keimbläschen 0,021 bzw. 0,02 mm. Seltsamerweise fand ich in den axillaren Gliedern fast nie Geschlechtsprodukte, vielmehr nur die leeren sich gabelnden Stränge. Dagegen waren kurz vor und nach der Teilungsstelle häufig dichtgedrängt Keimzellen vorhanden.

Der besseren Übersicht wegen möge hier eine Tabelle folgen. Die Messungen sind an Teilen eines weiblichen Tieres angestellt und lassen sich verhältnismässig auf die Mehrzahl der von mir untersuchten Tiere übertragen.

3. Verlauf und Bau der Genitalstränge im Kelch.

Zur Orientierung verweise ich auf die Wiedergabe eines günstig gelegenen Horizontalschnittes durch den Kelch, Fig. 22. Er zeigt den Verlauf der Generationsorgane in der oberen Kelchhälfte, zwischen dem Darm und dem ventralen Integument. Im Übergang zu einem Arme ist der Genitalstrang schief getroffen; seine Fortsetzung findet er im Kelch in einem weitverzweigten System gleichgebauter Röhren. Während bei *Antedon* die Genitalstränge nach der Beschreibung Hamanns, (13) S. 119 ein unregelmässiges Pentagon bilden, das im Kelch in einiger Entfernung das drüsige Organ umlagert, Perrier (21) S. 24 ff. und Fig. 162 dieselben aber als einzelne Stränge unmittelbar aus dem drüsigen Organ herleitet und zu den Armen ziehen lässt, fand Russo (24) im oberen Teile der Scheibe ein förmliches Netzwerk von Genitalsträngen, wie er Fig. 39, Taf. II, von einem erwachsenen *Antedon* darstellt. Mit letzterem übereinstimmend, fand ich bei *Pentacrinus* ebenfalls ein sehr

GRÖSSE IN MM:

Teil des Armes	Keimzellen	Keimblaschen	Keimfleck	Genitalröhre	Genitalgefäss
Übergang in den Kelch	0,0419 0,045 0,0294 0,031 0,0286	0,021 0,025 0,0128 0,0136 0,0147	etwa 0,004	Häufig Abschnitte ohne Eier	Durchmesser bis 0.06 wo Keimzellen vorh.; 0,024 wo keine vorhanden.
Brachialia I und II	0,081 0,0748 0,0683 0,0954	0,0354 0,0283 0,027 0,0418	0,0074 0,008 0,0071 0,0085	Kleine Strecken ohne Eier; ein Ei füllt das Lumen	
Brachialia IV bis VII	0,0968 0,1025 0,104 0,0973	0,0897 0,0412 0,064 0,0341	0,008 0,0092 0,00893 0,0084	Zwei Eier nebeneinander füllen das Lumen	Kaum kenntlich; bildet rings einen Kanal von 0,008 Weite.
Brachialia VIII bis X	0,0958 0,099 0,102 0,113 0,1096 0,1074	0,0326 0,031 0,0331 0,0382 0,042 0,0416	0,0086 0,009 0,0092 0,009 0,0094 0,00938	Zwei bis drei grosse Eier mit einigen sehr kleinen das Lumen füllend	Freier Teil ventralwärts gelegen; sein Durchmesser bis 0,035.
Brachialia höherer Ordnung	0,118 0,125 0,1184 0.108 0.107 0,136 0,124 0,1168	0,0291 0,034 0,0286 0,0241 0,032 0,0276 0,0315 0,0834	0,011 0,0103 0,01 0,009 0,009 0,0134 0,0087 0,0107	Zwischendurch einzelne sehr kleine Keimzellen vorhanden	Durchmesser bis 0,028.

stark verzweigtes Netzwerk, welches weite Maschen besass. Dasselbe durchzieht Bindegewebslücken, welche die Fortsetzung des Genitalkanals im Kelche zu bilden scheinen, und wird stellenweise eng von Bindegewebe umsponnen und begleitet.

Die Stränge des Netzwerks setzen sich ebenfalls aus zwei ineinander geschobenen Röhren zusammen. Die Wandung der äusseren Röhre, d. h. des Genitalgefässes, ist mit einem gleichen Epithel versehen, wie in den Armen. Unter diesem Epithel befindet sich wiederum eine Bindegewebslage von wechselnder Feinheit, in der man auf vereinzelte Kerne trifft. Ein eigentliches Endothel ist nicht vorhanden. Die Wandung der Genitalröhre selbst ist nur an sehr günstigen Stellen wahrzunehmen; sie besteht aus einer dünnen bindegewebigen Lamelle mit spärlichen Kernen. Perrier (21) stellt einen Querschnitt durch die Genitalröhre im Kelch von *Antedon* in seiner Fig. 144, Pl. XVII, dar. Die dort mit *a* bezeichnete Membran ist auch bei *Pentacrinus* vorhanden; es fehlt aber hier ein Innenepithel, welchem Perrier den Namen "epithelium genital" beilegt, und aus dem er die Keimzellen hervorgehen lässt.

Der Durchmesser der das Netzwerk bildenden Doppelröhren schwankt erheblich; dieselben sind teils nur schwach, teils sehr stark entwickelt. Unter andern fand ich als Durchmesser für:

Genitalgefäss	Genitalröhre
0,0571 mm	0,042 mm
0,0738 "	0,0573 "
0,025 "	? "
0,0416 "	0,023 "
0,0176 "	? "
0,0981 "	? "
0,101 "	0,096 "
0,127 "	0,0983 "

Man ersieht daraus, dass die Genitalstränge nach dem Übergang in die Kelchscheibe wieder im allgemeinen ganz bedeutend an Stärke zunehmen. Von *Antedon* hingegen berichtet Hamann (13) S. 119, dass der Genitalschlauch im Kelch einen bedeutend geringeren Durchmesser als in den Armen besitze; er bestimmt die Dicke desselben auf 0,02 mm, die der eigentlichen Genitalröhre auf 0,01 mm.

Als Inhalt des Genitalgefässes fand ich helles, äusserst feines Gerinnsel, das zuweilen eine schwache Färbung annahm, sowie gelbliche, meist grobkörnige Massen, an denen eine zellige Struktur nicht erkennbar war. Mitunter fanden sich wohlerhaltene Lymphkörperchen, auf die ich gleich zurückkommen werde. Die gelben Elemente trifft man auch in den intervisceralen Blutgefässen an. Cuénot (10) S. 425 hält sie: "pour des amibocytes migrants, . . . chargés d'apporter des produits de réserve dans les divers organs." Auch ich möchte die gelben Massen als Reservestoffe ansprechen, kann aber nicht wohl eigentliche Wanderzellen in ihnen erkennen.

Bei Cuénot, Études sur le sang et les glandes lymphatiques (11) werden die Lymphkörperchen der Echinodermen einer eingehenden Betrachtung unterzogen, S. 613–641. Von Crinoiden hat Cuénot anscheinend nur *Antedon* untersucht und berichtet hierüber: "Les plus nombreux (pl. XVIII, fig. 19) sont des amibocytes assez petits, 11 μ, . . . émettant de courts pseudopodes; ils sont donc assez différents de ceux des Oursins et des Astéries si bien caracterisés par le développement de leurs pseudopodes." Bei *Pentacrinus* senden die 0,022–0,03 mm grossen Lymphkörperchen dagegen im allgemeinen sehr lange Pseudopodien aus, wie Fig. 21 zeigt. Die Körper selbst enthalten eine kleinere oder grössere Anzahl unregelmässiger Körnchen und ein blasiges Gebilde. Mit den eben erwähnten gelben Elementen haben sie keine Ähnlichkeit. In der Länge der Pseudopodien finde ich zwischen *Pentacrinus* einerseits und den *Echinoidea* und *Asteroidea* anderseits nicht den geringsten Unterschied. Bei *Pentacrinus* scheinen sich die Pseudopodien stetig zu verjüngen und laufen in eine Spitze aus, während sie bei den eben erwähnten Klassen ihre Breite beibehalten, eine Differenz, die aber auch durch die Konservation hervorgerufen sein kann, da mir nur in Alkohol konserviertes Material zur Verfügung stand. Verbindungsbrücken zwischen zwei oder drei benachbarten Pseudopodien fand ich bei *Pentacrinus* nicht vor, während solche nach Cuénot, Pl. XVIII, Fig. 7 und 8, bei *Echinoidea* und *Asteroidea* häufig sind.

Die eigentliche Genitalröhre endlich birgt auch im Kelch Genitalzellen der verschiedensten Grösse. Fig. 20 gibt das Bild eines sehr stark vergrösserten Längsschnittes durch einen Teil eines weiblichen Genitalstranges. In Fig. 22 erkennt man der geringen Vegrösserung wegen nur die bereits weiter vorgeschrittenen Ureier als dunkle Körper, mit deutlich sich abhebendem hellerem Keimbläschen.

Auffallend sind die beträchtlichen Grössenunterschiede der im Kelch befindlichen Eizellen. Oft findet sich nahe beieinander jedes Wachstumstadium vertreten. Neben kleinen Zellen von 0,015 bis 0,017 mm Durchmesser, welche in Form und Aussehen genau mit den von Hamann (13) Taf. XII, Fig. 15 wiedergegebenen Plasmawanderzellen von *Antedon eschrichti* übereinstimmen, trifft man Eizellen, welche sich bereits sehr weit entwickelt haben und deren Durchmesser bis 0,11 mm beträgt.

Eine solche Zelle füllt in der Breite ein Gefäss fast bis zum Platzen aus. In engen Gefässen nehmen demgemäss die grösseren Eizellen eine sehr langgestreckte Gestalt an. Folgende Messungreihe möge die Verhältnisse genauer illustrieren :

Grösse der:	Keimzellen	Keimbläschen	Keimflecke	
	0,016	0,009	?	mm
	0,024	0,01	?	"
	0,0216	0,098	?	"
	0,0283	0,0113	0,001	"
	0,0641	0,0246	0,0062	"
	0,1018	0,0283	0,0108	"
	0,102	0,031	0,0109	"
	0,113	0,0462	0,0098	"
	0,098 . 0,0284	0,027	0,0079	"
	0,0475 . 0,19	0,045 . 0,019	0,00953	"
	0,04 . 0,11	0,031	0,00824	"

Verfolgen wir die Züge des Netzwerks der Genitalstränge zentralwärts, so gelangen wir schliesslich in die Nähe der Mundöffnung. Dort setzen sich die Genitalgefasse mit dem Geflecht der labialen Blutgefässe in Verbindung. Einzelne Ausläufer des letzteren treten an die Genitalgefässe heran und anastomosieren mit denselben, wie ich mit grosser Sicherheit aussprechen kann. Weiterhin umziehen die Genitalgefasse den Schlund in unmittelbarer Nähe und treffen dort mit Teilen des bindegewebigen Gefässes zusammen, welches, wie oben S. 19 erwähnt, aus der Mitte des dem drüsigen Organ angelagerten Zellkomplexes in der Richtung auf den Schlund hinführt. Gleich neben dem labialen Blutgefässgeflecht finden sich in der Genitalrohre mitunter schon weit entwickelte Eizellen von 0,043 bis 0,062 mm Grösse, an denen Keimbläschen und Keimfleck leicht kenntlich sind. Der günstige Umstand, dass die Genitalfässe ziemlich umfangreich sind und bereits grosse Eizellen enthalten, erleichtert die Feststellung ihres Verlaufs bei *Pentacrinus* bedeutend.

Nach dem Gesagten möchte ich nun wiederholen, dass ich die Zellen des fraglichen Komplexes für Plasmawanderzellen halte, welche sich loslösen, durch das um den Schlund ziehende Rohr zum labialen Blutgefässgeflecht hinwandern, um sich endlich in den Strängen der Scheibe und der Arme und Pinnulae zu heranwachsenden Ei- bzw. Samenzellen zu entwickeln. Weiterhin scheint mir für diese Ansicht vornehmlich folgendes zu sprechen.

In den Genitalröhren von *Antedon* fand Ludwig (18) S. 31 und Taf. XV, Fig. 15, in den Armen einen inneren Wandbelag von nur 0,0075–

0,0085 mm grossen Zellen, aus denen sich erst später in den Pinnulae die Eier entwickelten. Ausführlicher, aber im wesentlichen mit Ludwig ubereinstimmend, beschrieb Hamann (13) S. 118, die in den Genitalröhren von *Antedon* vorgefundenen Zellen. A. Lang (16) S. 1089 und 1090, Fig. 776, spricht von einer Wandverdickung, einer Leiste, von der aus sich stets neue Keimzellen bilden. Perrier (21) S. 51 endlich nennt den Innenbelag der Genitalröhren: l'épithélium producteur des œufs, bzw. l'épithélium testiculaire.

Dagegen haben wir bei der Besprechung der Genitalröhren von *Pentacrinus decorus* gesehen, dass dort weder ein innerer Zellbelag, ein Epithel, noch eine Leiste vorhanden ist, aus welchen sich Keimzellen bilden könnten. Vielmehr fanden wir die aus einer dünnen Lamelle gebildete Genitalröhre des Armes von weit entwickelten Ei- oder Samenzellen erfüllt.

Hamann sprach (14) S. 83 zuerst aus: Er betrachte die Zellen in der Genitalröhre nicht als festsitzende Epithelzellen, sondern als Wanderzellen, welch in die Pinnulae einwandern, um dort zu reifen. Weiterhin sagt er: "Die Geschlechtsprodukte entstehen an besonderen Stellen der Genitalröhren aus Urkeimzellen", ohne aber solche Stellen des Näheren zu bezeichnen. — Dass die Keimzellen in der Tat Wanderzellen sind, dafür scheint mir *Pentacrinus decorus* ein gutes Beispiel zu liefern. Schon aus der veränderlichen Form der jüngeren Keimzellen kann man auf eine amöboide Fortbewegung schliessen; bereits ziemlich weit in der Entwicklung vorgeschrittene Keimzellen zeigen in hohem Grade die Fähigkeit, sich sehr engen Röhren anzupassen, wie wir weiter oben gesehen haben.

Da wir nun bereits im Kelch von *Pentacrinus* eine grosse Anzahl weit entwickelter Eizellen fanden, und eine Epithel, aus dem sich Keimzellen bilden und loslösen könnten, nicht vorhanden ist, haben wir meiner Meinung nach die Ursprungsstelle der Urkeimzellen im Kelch zu suchen und kommen naturgemäss auf den dem drüsigen Organ angelagerten Komplex zurück, dessen Zellen die grösste Ähnlichkeit mit Plasmawanderzellen, bzw. Urkeimzellen besitzen (vgl. Fig. 16 u. 20).

Es erübrigt noch der Versuch, Klarheit über das Verhältnis zwischen dem drüsigen Organ und dem ihm angelagerten Zellkomplex zu erhalten. Früher sprach man das drüsige Organ allgemein als Mittelpunkt des Gefässsystems an (Ludwig, Greef u. a. m.), neuerdings wird es als Genitalstolo bezeichnet (Perrier, Hamann).

Hamann (13) S. 119 verfolgte beim erwachsenen *Antedon* die Genitalstränge von den Armen her in die Scheibe bis zur unmittelbaren Nähe des drüsigen Organs, ohne aber einen Zusammenhang mit diesem finden zu können.

Perrier (21) kam auf Grund entwicklungsgeschichtlicher Forschungen zuerst zu der Ansicht, das drüsige Organ selbst sei der einzige Ausgangspunkt der Generationsorgane. Von ihm aus lässt er die Genitalstränge ihren Ursprung nehmen und zu den Armen hinziehen. Er legt ihm daher den Namen "stolon génital" bei und erklärt es als homolog der "glande ovoide" der Asteriden und Echiniden (S. 211).

Zu einem hiervon abweichenden Ergebnis kommt A. Russo, der sehr genaue, ebenfalls der Hauptsache nach entwicklungsgeschichtliche Studien an *Antedon* gemacht hat. Er beobachtete das Auftreten von Genitalzellen an verschiedenen Körperteilen der jungen Larve, und berichtet darüber (24) S. 11 ff.: "Sul principio alcune cellule celomiche, che formano una delle due pareti del mesentere, . . . s'ingrandiscono molto, aumentando anche di numero come si vede in *g* delle fig. 15, 23, 36, 42. In tal modo si forma un cumulo di cellule caratteristiche per le dimensioni molto grandi, e per il loro nucleo grosso e rotondo, che formano il primo accenno della gonade." Dieser von Russo Gonade genannte Komplex liegt nach seiner Schilderung in der Nähe des Oesophagus, etwa in der Mitte des Interradius *CD*.

Fast gleichzeitig mit dieser Bildung sah Russo in der Nähe des gekammerten Organs den oben genannten ähnliche Zellelemente entstehen, welche sich lebhaft vermehren und später das drüsige Organ, "l'organo assile," bilden.

Schliesslich fährt er dann weiter unten fort: "In corrispondenza dell' esofago, ben presto nella larva alquanto avanzato nello sviluppo, dopo che l'organo assile si è constituito, si differenzia dalle cellule peritoneali un nuovo gruppo di elementi sessuali. Il processo, con cui questi si formano è chiaramente visibile nella fig. 25, dove alcune cellule celomiche sono molto ingrossate e sporgenti nella cavità generale, in modo da formare una gemma. Esse, proliferando si mettono in rapporto con l'organo assile mentre in seguito formano attorno l'esofago una serie di cordoni genitali cavi, aventi diverse dimensioni. . . . Dai cordoni periesofagei emanano però molti cordoni cellulari pieni, i quali si anastomizzano fra di loro formando un intreccio, come si vede nella fig. 40, ricavata da una sezione orizzontale di grosso *Antedon*."

Die von Russo zuerst erwähnte Zellgruppe im Interradius *CD* reduzierte sich später und verschwand. Die zuletzt genannte Gruppe dagegen blieb bestehen und trat an das drüsige Organ heran. Aus ihr wird der eigentliche Bildungsherd der Urkeimzellen.

Meine an *Pentacrinus* gemachten Beobachtungen stehen mit denen Russos in vollem Einklang. Es ist unschwer zu erkennen, dass der Komplex der Urkeimzellen nicht aus dem drüsigen Organ hervorgegangen ist; es gelang mir nicht einmal mit Gewissheit nachzuweisen, dass die Schläuche des letzteren sich zu dem Komplex hin öffnen, obwohl ich dies für wahrscheinlich halte; aus meinen Schnitten liess sich bisher nur eine Randanlagerung und Verbindung unter einem Epithel erkennen. Die Zellelemente beider Organe sind sehr voneinander verschieden und deutlich gegeneinander abgegrenzt.

Denkt man sich den von mir bei *Pentacrinus* gefundenen Zellkomplex sehr verkleinert, so wurde er eine Gemme bilden, wie Russo sie von der jungen *Antedon*-Larve beschreibt und in seiner Fig. 25 darstellt. Auch die bei meinen erwachsenen Tieren noch vorhandene Verbindung mit dem Cölomepithel des Schlundes stimmt mit den von Russo gemachten Beobachtungen überein.

Zuerst möchte es scheinen, dass die Form der Komplexe einen Unterschied bedinge, indem bei *Antedon* ein dicker Strang vorhanden ist, welcher sich dem drüsigen Organ eng anschmiegt, während es bei *Pentacrinus* zur Ausbildung einer Scheibe kommt. Bei näherer Untersuchung jedoch ergibt sich aus dem Verhalten der Komplexe der Urkeimzellen bei *Pentacrinus decorus*, bei dem pentacrinoiden Larvenstadium von *Antedon* und bei dem erwachsenen *Antedon* eine interessante, phylogenetische Beziehung. *Pentacrinus* behalt zeitlebens die Gemmenform des Komplexes bei, welche bei *Antedon* nur im pentacrinoiden Stadium vorübergehend vorhanden ist, während der erwachsene *Antedon* bereits eine höhere Modifikation dieser Form aufweist, einen weiteren Fortschritt phylogenetischer Entwicklung darstellt.

Die Homologie der "glande ovoide" mit dem drüsigen Organ allein halte ich nicht fur vollständig; vielmehr kommt erst durch die Vereinigung des drüsigen Organs mit dem eigentlichen Bildungsherd der Urkeimzellen ein Komplex zustande, der mir in seiner Gesamtheit der "glande ovoide" der Asteriden und Echiniden gleichwertig scheint.

Zusammenfassung.

1. ANTIAMBULACRALES NERVENSYSTEM.

Ausser dem bereits früher bekannten Ring in den Radialia, fanden wir schon in den Basalia Connective, welche die vom Zentralorgan ausgehenden Stränge paarweise verbanden. Die Paare verlaufen bis zu dem in den Radialia befindlichen Ring getrennt parallel und vereinigen sich erst dort wieder. Das Chiasma ist einfacher wie bei *Antedon* gebaut. In jedem axillaren Gliede ist ein Chiasma vorhanden.

2. Gekammertes Organ.

Das gekammerte Organ hat keine Fortsetzungen nach oben; seine fünf Kammern enden blind geschlossen. Nach unten sendet es Auslaufer in den Stiel, von denen in den Nodien die Cirrengefässe ausgehen. Gebildet wird es von einer dünnen Bindegewebslage, die mit einem deutlichen Endothel versehen ist. Seine sämtlichen Teile enthalten als charakteristiches Merkmal dunkle Körner, deren Natur uns zweifelhaft blieb. Im oberen Teil des gekammerten Organs verlaufen im Innern von Wand zu Wand ziehend schwache bindegewebige Stränge, die frei von Kalkbildungen sind.

3. Drüsiges Organ.

Vom drusigen Organ aus geht in den Stiel der Achsenstrang, der aus einer einfachen Röhre mit sehr engem Lumen besteht. Die ihn bildenden Zellen besitzen Ähnlichkeit mit denen des drüsigen Organs.

Im Kelch wird das drüsige Organ von einer sehr grossen Anzahl von Schläuchen gebildet, zwischen denen schwache Bindegewebsfasern vorkommen. Ob alle Schläuche untereinander in Verbindung stehen, liess sich nicht feststellen. Die Gesamtheit der Schläuche lässt annähernd in ihrer Mitte ein kleines Lumen frei, gegen das sie durch Cölomepithel abgegrenzt ist. Im unteren Teil des drüsigen Organs wird das Lumen von einzelnen Bindegewebssträngen durchzogen. Ich spreche es als abgekapselten Teil der Leibeshöhle an. Dem oberen Teil des drüsigen Organs ist ein umfangreiches Zellpolster angelagert. Dasselbe bildet mit dem drüsigen Organ einen oben offenen Sack. In diesen treten vom labialen Blutgefässgeflecht her zahlreiche Gefässe ein.

Ein direkter Zusammenhang der Schläuche des drüsigen Organs mit Blutgefässen war nicht nachweisbar, wohl aber das Eintreten der letzteren unter das Epithel, welches das drüsige Organ umhüllt.

4. Die Geschlechtsorgane.

Den Ausgangspunkt der Urkeimzellen bildet der dem drüsigen Organ angelagerte Komplex. Von diesem aus geht ein Strang, welcher den Schlund in unmittelbarer Nähe umzieht, zum labialen Gefässgeflecht hin. Durch Verzweigung kommt unterhalb des Integuments der Kelchdecke ein umfangreiches Netzwerk von Genitalstrangen zustande. Von dem Netzwerk aus ziehen Ausläufer durch die Arme zu den Pinnulae. Die

Stränge und Ausläufer bilden Doppelröhren. Die äussere Röhre, das Genitalgefäss, ist ein Blutgefäss; die innere Röhre besteht nur aus einer feinen bindegewebigen Lamelle und enthält Geschlechtsprodukte. Die Genitalröhre hat kein Innenepithel.

Das Zellpolster, von welchem die Plasmawanderzellen ausgehen, um sich bald zu Ei- oder Samenzellen zu entwickeln, wird von Blutgefässen umzogen und durchlaufen. Es ist meiner Meinung nach nicht wohl möglich, Blutgefässsystem und Generationsorgane scharf zu sondern. Beide sind aufs engste miteinander verbunden. Ob sich vielleicht die Generationsorgane überhaupt als Blutgefässe betrachten lassen, worauf Ludwig (18) S. 89 hinweist, darüber könnte ich mir kein volles Urteil bilden, da mir nur ausgewachsene Tiere zur Verfügung standen.

Bonn, im Dezember 1904.

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ERKLÄRUNG DER ABBILDUNGEN.

Die folgenden Buchstaben gelten für alle Figuren:

a, Achenstrang;
bg, Bindegewebe;
cep, Cölomepithel;
co, Centralorgan;
d, Darm;
dep, Darmepithel;
dn, dorsaler Nervenstrang;
do, drüsiges Organ;
G, Bildungsstätte der Urkeimzellen;
go, gekammertes Organ;
gz, Ganglienzelle;
kgr, Kalkgrundsubstanz;
mo, Mundöffnung;
nr, Nervenring in den Radialia;
oe, Oesophagus;
sy, Syzgie.

TAFEL I.

Fig. 1. Längsschnitt durch den Kelch von *Pentacrinus decorus*. Kopie nach P. H. Carpenter (5) Pl. LXII, $^1/_2$ mal verkleinert und etwas umgeändert.

Erklärung der Farben: Nervensysteme gelb; Blutgefässe roth; Wassergefässsystem grün; drüsiges Organ schwarz; Generationsorgane grauschwarz. *B*, Basale; *R*, Radiale; C_1, Costale; D_1, Distichale *I; ap*, ambulacrale Platten; *kp*, Kelchporen; *sap*, subambulacrale Platten; *abc*, ambulacrales Nervensystem; *st*, Steinkanal; *lbg*, labiales Blutgefässgeflecht; *ib*, intervisceraless Blutgefäss; *wg*, Wassergefäss; *r*, Rectum; *gs*, Genitalstrang.

Fig. 2. Tangentialer Langsschnitt durch die untersten Armglieder, um die Chiasmata, *ch I, II* und *III* zur Anschauung zu bringen. *R*, Radiale; *C*, Costale; *D*, Distichale; *P*, Palmare; *B*, Brachiale; *dst*, Dorsalstrang.

Fig. 3. Querschnitt durch ein Nodium des Stieles, so dass die von den Fortsetzungen des gekammerten Organs *fg* ausgehenden Cirrengefässe *cg* getroffen sind. *ep*, Epithel des gekammerten Organs; *n*, Nervenschicht; n_1, deren peripherische zu den Cirrengefässen hinziehende Fasern; *k*, dunkle Körner. Zeiss, Obj. E, Oc. 2.

Fig. 4. Querschnitt durch ein Cirrengefäss mit der umgebenden Nervenschicht *n* im Stiel. *cg*, Lumen des Gefässes; *sc*, Septum. Zeiss, Obj. C, Oc. 2.

Fig. 5. Querschnitt durch ein Cirrengefäss, nachdem dasselbe in den Cirrus eintrat. Die Nervenschicht *n* hat sich auf die beiden Seiten gezogen. Zeiss, Obj. C, Oc. 2.

Fig. 6. Zwei Ausläufer, *aus*, des dorsalen Armnervenstranges *dn*, deren feinste Enden, *en*, in der Kalkgrundsubstanz verlaufen. *k*, begleitende Kerne. Zeiss, Obj. C, Oc. 2.

Fig. 8. Teil eines Querschnittes durch ein Nodium des Stieles in Höhe der in die Cirrengefässe ziehenden Septen *sc*. *n*, Nervenschicht und deren peripherische Fasern; *ep*, Epithel des Cirrengefässes. Zeiss, Obj. C, Oc. 2.

Fig. 9. Teil eines Längsschnittes durch ein Nodium. *sp*, Septum; *cg*. Beginn eines Cirrengefässes; *n*, Nervenfaserschicht; *go*, Fortsetzung des gekammerten Organs. Zeiss, Obj. C, Oc. 3.

Fig. 10 u. 11. Längs- und Querschnitt durch den Achsenstrang. *z*, Zelle; *ke*, Kern. Fig. 10: Zeiss, homog. Immers. 1/18. Fig. 11: Zeiss, Obj. F, Oc. 4.

Fig. 6.

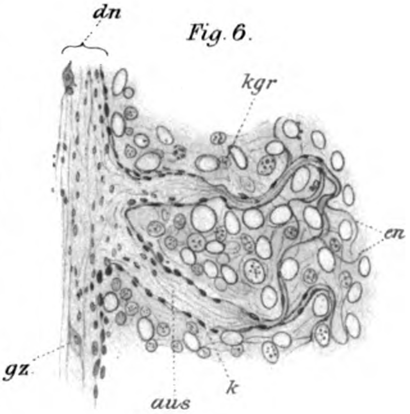
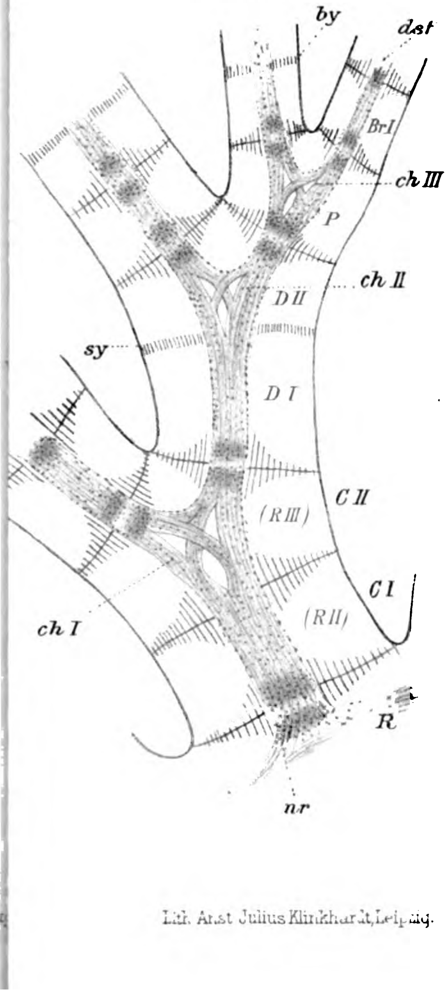


Fig. 2.



Au

Lith. Anst. Julius Klinkhardt, Leipzig.

TAFEL II.

Fig. 7 *a–h*. Querschnitte zur Erläuterung des Verhältnisses des gekammerten Organs zum drüsigen Organ, bzw. Achsenstrang. Zeiss, Obj. C, Oc. 1.

Fig. 7 *a*: Querschnitt im Stiel. *n*, Nervenfaserschicht. Fig. 7 *b* u. *c*: In Höhe des Zentralorgans *co*. *k*, dunkle Körner. Fig. 7 *d*: In Höhe der Connective *cb* in den Basalia. *bg*, Bindegewebe der Leibeshöhle. Fig. 7 *e* u. *f*: In Höhe der Radialia. *ubg*, unverkalktes Bindegewebe; *k*, dunkle Körner. Fig. 7 *g*: Oberster Teil des gekammerten Organs; *ble*, blindes Ende einer Kammer. Fig. 7 *h*: Veranschaulichte Lage und Gestalt des drüsigen Organs *do* kurz nach dem Endigen des gekammerten Organs.

Fig. 12 *a* u. *b*. Wandung des gekammerten Organs. Fig. 12 *a* von der Seite, Fig. 12 *b* von der Flache aus gesehen. *epz*, Endothelzelle; *bg*, Bindegewebslamelle. Zeiss, Obj. E, Oc. 2.

Fig. 13. Stück eines Querschnittes durch die breiteste Stelle des drüsigen Organs. *ger*, Gerinnsel; *schl*, Schlauch; *bg*, Bindegewebsfasern; *L*, inneres Lumen; *ep*, dessen Epithel, welches dem Cölomepithel *cep* gleich ist. Zeiss, Obj. D, Oc. 2.

Fig. 14. Querschnitt durch den von drüsigem Organ und Bildungsherd der Urkeimzellen gebildeten Sack. *R*, zum Schlund hinführende Röhre; *bl*, Blutgefässe; *ep*, beide Organe unter sich vereinigendes Cölomepithel. Zeiss, Obj. C, Oc. 1.

Fig. 15. Längsschnitt durch den Sack. *wg*, Wassergefäss: *st*, Steinkanal; *T*. Tentakel; sonst wie in Fig. 14. Zeiss, Obj. B, Oc. 2.

Fig. 18. Längsschnitt durch den Genitalkanal *gc* eines männlichen Tieres. Die Genitalröhre *gr* ist mit Samenzellen erfüllt. *bgl*, Wand der Genitalröhre; *ep*, Epithel des Genitalgefässes *gf*; *ger*, Gerinnsel. Zeiss, Obj. C, Oc. 4.

Fig. 18.

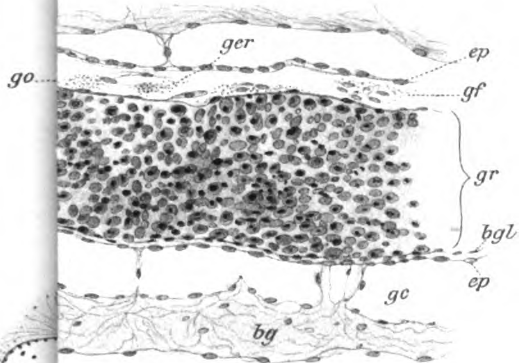


Fig. 15.

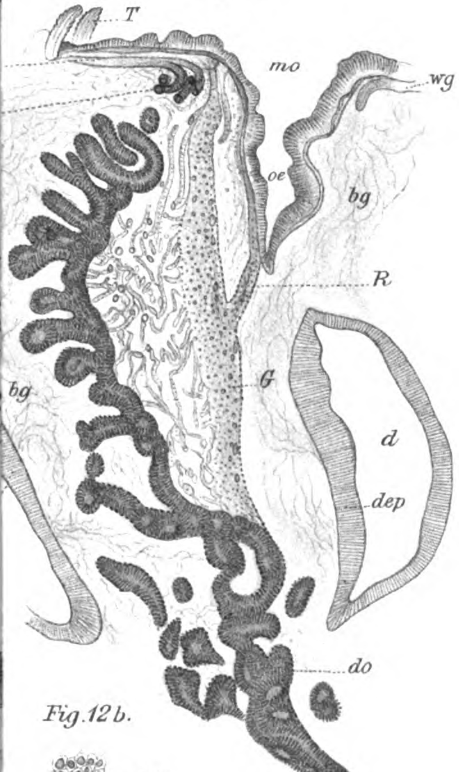
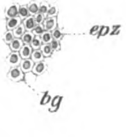


Fig. 12 b.



Aug. Reiche

Lith. Anst. Julius Klinkhardt, Leipzig.

TAFEL III.

Fig. 16. Teil des dem drüsigen Organ angelagerten Komplexes. *bl*, Blutgefässe; *plw*, Plasmawanderzellen; *cep*, Cölomepithel; *I*, Innenraum des Sackes; *A*, Leibeshöhle. Zeiss, Obj. F, Oc. 2.

Fig. 17. Teil eines Längsschnittes durch den Arm eines erwachsenen weiblichen Tieres. *gc*, Genitalkanal; *ger*, Gerinnsel; *ep*, Epithel des Genitalgefässes; *ez*, Eizelle; *kb*, Keimbläschen; *kf*, Keimfleck. Zeiss, Obj. AA, Oc. 2.

Fig. 19. Teil eines Querschnittes durch den Arm eines männlichen Tieres. *gc*, Genitalkanal; *ger*, Gerinnsel; *sz*, Samenzelle; *dc*, Dorsalkanal; *gef*, Genitalgefäss. Zeiss, Obj. F. Oc. 1.

Fig. 20. Genitalgefäss *gf* im Kelch längs durchschnitten. *gr*, Genitalröhre; *ep*, Epithel des Genitalgefasses; *ger*, Gerinnsel; *krm*, gelbe körnige Massen; *plw*, Plasmawanderzellen; *ez*, bereits weit entwickelte Eizelle. Zeiss, homog. Immersion 1/18.

Fig. 21 *a*. Lymphkörper *L* in einem Blutgefass *bl*. *ger*, Gerinnsel. Zeiss, Obj. D, Oc. 1.

Fig. 21 *b*. Lymphkörper, stärker vergrössert. *blg*, blasiges Gebilde; *ps*, Pseudopodien. Zeiss, Obj. F, Oc. 1.

Fig. 22. Teil des Netzwerkes der Genitalstränge im Kelch. Horizontalschnitt, zwischen Darm und Integument der Kelchdecke gelegen. *A*, Arm; *gk*, Genitalkanal; *gs*, Genitalstrang im Übergang zum Arme; *Ez*, weit entwickelte Eizellen; *gf*, Genitalstränge im Kelch; *kp*, Kelchporen. Zeiss, Obj. C. Oc. 1.

Fig. 20.

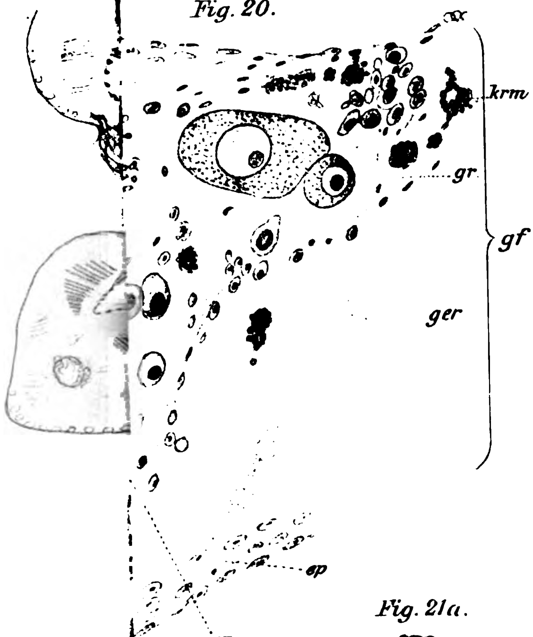


Fig. 21a.

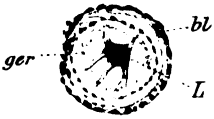
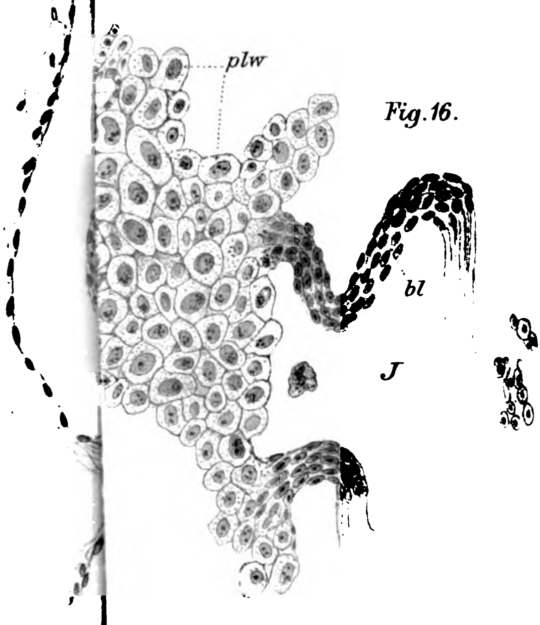


Fig. 16.



Aug. Reich.

Lith. Anst. Julius Klinkhardt, Leipzig.

Dorsal spines hardly projecting beyond the skin. Scales pedunculate, pluricarinate on head, shoulders, and belly. Teeth $\frac{72}{30}$; upper lanceolate, more than twice as numerous as lower, in two groups at each side, cusps shaped like a spear-head, subtriangular in transsection, several rows in function; lower broad, compressed, cusps with a deep notch at the outer edge, apex raised, cutting edge rising obliquely toward the angles of the mouth, one row in function; no median tooth at the lower symphysis. Labial folds hidden in the deep, straight, oblique folds crossing the angles of the mouth; lower short, upper much longer and reaching half-way to the middle of the mouth, that is, a little farther than the groove. Nostrils widely separated, nearer to end of snout than to mouth. Spiracles medium, superior, one diameter backward and two diameters distant from the orbit, with a large antespiracular chamber, extending forward from the valve to a point above the posterior angle of the orbit, valve with folds on its inner side like gill lamellae. The lining of the prespiracular chamber is without shagreen and apparently is sensitive. Posterior margin of pectoral oblique, inner angle much shorter; base of second dorsal longer and fin higher than in first dorsal, hinder angle produced, base equal one fifth of its distance from the first dorsal base; end of pectoral not reaching to a vertical from the first dorsal spine; end of ventral base reaching a vertical from the spine of the second dorsal.

Uniform dark brown.

No. 1037, Mus. Comp. Zoöl. Total length, $31\frac{1}{4}$ inches.

Hab. Yenoura, Suruga Gulf, and Sagami Bay, Japan.

Named in honor of Alan Owston, Esq.

Pristis clavata, sp. nov.

The group of species of this genus containing *P. pectinatus* Lath., 1794, and *P. zysron* Blkr., 1852, is that in which the present form most naturally falls.

Rostral teeth in twenty-one pairs, not trenchant behind. Origin of the first dorsal one fourth of the length of its base farther backward than the origin of the ventral. Pectoral origin in advance of the first gill cleft nearly the width of the internarial space, or the length of the orbit; outer angle of pectoral fin blunt and bluntly rounded. Second dorsal smaller than first dorsal, length equal about three fifths of the length of the caudal fin, or one sixth shorter than first dorsal. Caudal fin obliquely truncated without an anterior lobe on the subcaudal portion. Total length, $24\frac{3}{8}$ inches.

No. 733, Mus. Comp. Zoöl.

Hab. "Queensland, Australia."

Distinguished from *Pristis pectinatus* by the smaller number of rostral teeth and the position of the first dorsal backward of the origins of the ventrals; from *P. zysron* by the smaller number of teeth in the saw, the more forward origin of the first dorsal, and the second dorsal smaller than the first dorsal; and from *P. zephyreus* J. & S., 1895, by the backward origin of the first dorsal, the lobeless caudal fin, and the spacing of the rostral teeth.

The following Publications of the Museum of Comparative Zoölogy are in preparation: —

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," as follows: —

H. AUGENER. The Annelids of the "Blake."
C. HARTLAUB. The Comatulae of the "Blake," with 15 Plates.
H. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

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H. B. BIGELOW. The Siphonophores.
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Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S N., Commanding.

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